

COMPUTER SYSTEMS AND SERVICES OPPORTUNITIES
IN EXPLORATION AND PRODUCTION

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Opportunities in Petroleum
Exploration and Production (7/81)

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Planning Services for Management

COMPUTER SYSTEMS AND SERVICES OPPORTUNITIES
IN
PETROLEUM EXPLORATION AND PRODUCTION

FINAL REPORT
PREPARED FOR
CONTROL DATA CORPORATION
MINNEAPOLIS, MN 55440

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COMPUTER SYSTEMS AND SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

ABSTRACT

The study investigates the market potential for offering computer services for petroleum, geophysical data processing, and reservoir simulation for petroleum production scheduling and planning. Using Society of Exploration Geophysicists (SEG) industry and survey respondent data, forecasts were developed of EDP expenditures for both in-house and computer services for seismic data processing, interpretation, well log analysis, and mapping for the 1980-1985 timeframe. Using expert opinion and survey respondent data, forecasts were developed of EDP and computer services expenditures for petroleum reservoir simulation for the same timeframe. The study also addressed computer systems requirements in the area of vector arithmetic, array processors, floating point word size, graphic terminals, DBMS, and application software.



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PETROLEUM EXPLORATION AND PRODUCTION

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I EXECUTIVE SUMMARY

INPUT

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- RECOMMENDATIONS

- EXPLORATION

- . COMPUTER SERVICES

- THE MARKET IS HIGHLY ATTRACTIVE AND RAPIDLY EXPANDING. A WELL PLANNED ENTRY CAN HARDLY FAIL
 - ENTER THE MARKET NOW!
 - OFFER TOTAL GEOPHYSICAL DATA PROCESSING SERVICE
 - . CYBER HARDWARE
 - . SOFTWARE
 - . PROFESSIONAL SERVICES
 - STICK TO THE BASICS FOR MARKET ENTRY
 - . MAKE IT WORK
 - . DEMONSTRATE CAPABILITY, QUALITY, RESPONSIVENESS AND COST EFFECTIVENESS EARLY
 - . PLAN 3-D AND OTHER ADVANCED TECHNIQUES FOR LATER OFFERINGS

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- RECOMMENDATIONS

- EXPLORATION

- COMPUTER SERVICES (Cont.)

- ESTABLISH CYBER CENTERS IN HOUSTON AND DENVER
 - INTERCONNECT THROUGH CYBERNET
 - PRIMARILY FOR BATCH PROCESSING OF TAPE INPUT
 - INITIALLY OFFER REMOTE BATCH/ INTERACTIVE SERVICES FOR PARAMETER SELECTION AND BASIC ANALYSIS FOR PROCESSING/REPROCESSING
 - LATER EXPAND OFFERING THROUGH MICRODRIVEN INTELLIGENT TERMINAL FOR:
 - INITIAL OFFERINGS
 - STRATIGRAPHIC ANALYSES
 - SYNTHETIC MODELING
 - THEN OFFER DISTRIBUTED PROCESSING TO REMOTE POINTS USING 32BIT MINI FOR:
 - PRIOR OFFERINGS
 - SELECTED SEISMIC PROCESSING
 - GRAPHICS
 - MAPPING

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- RECOMMENDATIONS

- EXPLORATION

- . COMPUTER SERVICES (Cont.)

- ACQUIRE SEISMIC PROCESSING COMPANY(s)
FOR PERSONNEL AND BUSINESS BASE
 - ACQUIRE GEOPHYSICAL SOFTWARE VENDOR(s)
 - . GUARANTEE AGGRESSIVE R & D EFFORT
 - . OVER TIME DEVELOP USER FRIENDLY SOFTWARE
 - . TEKNICA RESOURCES A POSSIBILITY
 - OFFER TENNECO A SPECIAL ARRANGEMENT TO DO THEIR GEOPHYSICAL PROCESSING
 - . FM ARRANGEMENT
 - . BETA TEST SITE
 - . GUARANTEED BLOCK TIME FOR PRIORITY PROCESSING
 - OFFER INDEPENDENT(s) SPECIAL ARRANGEMENT TO HELP GROW DISTRIBUTED PROCESSING CAPABILITIES (BETA TEST SITES)
 - . PIONEER PRODUCTION
 - . SEAWARD RESOURCES

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- RECOMMENDATIONS

- EXPLORATION

- . COMPUTER SERVICES (Cont.)

- OFFER EDUCATIONAL SERVICES TO:

- . TRAIN COMPUTER ANALYSTS IN
GEOPHYSICAL DATA PROCESSING
INCLUDING DATA BASE MANAGEMENT
SYSTEMS
- . TRAIN GEOPHYSICISTS IN COMPUTER
AIDED SEISMIC PROCESSING ANALYSIS
INTERPRETATION, MODELING, AND
DATA BASE MANAGEMENT SYSTEMS

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- RECOMMENDATIONS

- EXPLORATION

- . COMPUTER SYSTEMS

- DISTRIBUTE INTELLIGENCE TO THE NODE FOR:

- . SELECTED SEISMIC PROCESSING
 - . INTERACTIVE SEISMIC ANALYSIS AND MODELING
 - . WELL LOG DIGITIZING/ANALYSIS
 - . DISTRIBUTED DATA BASES
 - . MAPPING

- CAD/GRAPHICS

- PROVIDE DATA ENCRYPTION FOR REMOTE EXPLORATION DATA PROCESSING

- . DIGICON HAS SET THE TREND
 - . IBM IS EXPECTED TO FOLLOW IN FUTURE SYSTEMS

- INVESTIGATE CAPABILITY OF DATA GENERAL VS8000 FOR REMOTE MINI

- . 32BITS
 - . VECTOR CAPABILITY
 - . OPERATING SYSTEM MUST BE VIRTUAL AND "WORK"
 - . INTERFACE TO LARGE/SUPER CYBER MAINFRAMES

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COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- RECOMMENDATIONS

- EXPLORATION

- COMPUTER SYSTEMS (Cont.)

- USE FLOATING POINT SYSTEMS ARRAY PROCESSORS
AT LEAST ON AN INTERIM BASIS

- 64BIT WORD SIZE

- DUAL PIPELINES FOR SIMULTANEOUS
32BIT FP OPERATIONS

- DOUBLE PRECISION IN SAME EXECUTION
TIME AS SINGLE

- STRUCTURED FORTRAN PROGRAMMABILITY

- $\frac{1}{2}$ TO 2MB MEMORY IN $\frac{1}{2}$ MB INCREMENTS

- FULL MEMORY ADDRESSABILITY

- LOOK AT CAD/CAM VENDORS FOR MICRO/MINI-
DRIVEN GRAPHICS TERMINAL SYSTEMS

- COMPUTER VISION

- CALMA

- AUTOTROL

- INTERGRAPH

- SUMMA GRAPHICS

- MDSI

- AM BRUNIG

- } \$300-600K COLOR

- } \$50-100K BLACK/WHITE

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COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- RECOMMENDATIONS

- EXPLORATION

- COMPUTER SYSTEMS (Cont.)

- INITIATE PLANNING TO SELECT/HAVE
DEVELOPED:

- HIERARCHICAL DATA BASE MANAGEMENT
SYSTEM FOR EXPLORATION DATA PROCESSING

- DIGITIZED SEISMIC INTERPRETATIONS

- DIGITIZED WELL LOGS

- MAPPING DATA

- CAD PACKAGE/SYSTEM FOR MAPPING
APPLICATIONS

- GRAPHICS FOR INTERACTIVE COMPUTER
AIDED SEISMIC INTERPRETATION

- HIGH-RESOLUTION COLOR TERMINAL

- SYNERCOM SOFTWARE A POSSIBILITY

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- RECOMMENDATIONS

- PRODUCTION

- . COMPUTER SERVICES

- THE MARKET IS EXCELLENT AND RAPIDLY EXPANDING
 - EXPAND MARKET NOW!
 - . CRAY-1 ALREADY IN AT BCS, UNITED TELECOMMUNICATIONS AND PENDING AT UNIVERSITY COMPUTING
 - . SPREAD THE WORD FOR CYBER SYSTEM
 - . HOLD THE FORT UNTIL CYBER 205 MORE WIDELY AVAILABLE
 - OFFER CONSULTING SERVICES AS WELL AS CYBER REMOTE BATCH RESOURCES
 - . TO SEMI-MAJORS AND LARGE INDEPENDENTS
 - . AS A TEST BED FOR MAJORS
 - . AS A MEANS OF UPGRADING SOFTWARE PRODUCTS

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- RECOMMENDATIONS
 - PRODUCTION
 - . COMPUTER SERVICES (Cont.)
 - ACQUIRE RESERVOIR MODELING SOFTWARE/PROFESSIONAL SERVICES VENDOR
 - . EXPERTISE FOR OFFERING SERVICES TO SEMI-MAJORS AND INDEPENDENTS
 - . GUARANTEE AGGRESSIVE R&D EFFORT
 - . DEVELOPMENT OF PETROLEUM PRODUCTION AND FINANCIAL PLANNING MODELS
 - . SCIENTIFIC SOFTWARE CORPORATION A POSSIBLE CANDIDATE
 - DEVELOP AND OFFER PETROLEUM PRODUCTION AND FINANCIAL PLANNING MODELS
 - . INTERFACE WITH RESERVOIR MODELS
 - . IN POST-PROCESSING
 - . ON INTERACTIVE BASIS USING GRAPHIC TERMINALS
 - . VALUATION
 - . DECLINE CURVE ANALYSIS
 - . A MORE RATIONAL WAY TO DO PRODUCTION PLANNING

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- RECOMMENDATIONS

- PRODUCTION

- . COMPUTER SYSTEMS

- UPGRADE SCALAR CAPABILITY
OF CYBER 205
 - UPGRADE FORTRAN COMPILER
 - . AUTOMATED VECTORIZATION
 - . OPTIMIZATION FOR CYBER 205
RESOURCES
 - . IMPROVE COMPATIBILITY WITH IBM
TO EASE CONVERSIONS
 - . IMPLEMENT STRUCTURED FORTRAN
PREPROCESSORS
 - UPGRADE OPERATING SYSTEM
 - . REWRITE IF NECESSARY TO ACHIEVE
VIRTUAL SYSTEM
 - . REVISE INTERACTIVE PART TO BE
USER FRIENDLY
 - . REVISE I/O TO HANDLE ASYNCHRONOUS
COMMUNICATIONS
 - LOW SPEED (UP TO 9600 BAUD)
FOR INTERACTIVE AND REMOTE ENTRY
 - HIGH SPEED TO 56 KILO BAUD FOR
SATELLITE TRANSMISSION

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COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- RECOMMENDATIONS

- PRODUCTION

- COMPUTER SYSTEMS (Cont.)

- UPGRADE SYSTEM UTILITIES

- IMPROVE SORT PACKAGE

- PROVIDE USER FRIENDLY REMOTE
CRT INTERFACES

- INITIATE PLANNING TO SELECT/HAVE
DEVELOPED:

- HIERARCHICAL DATA BASE MANAGEMENT
SYSTEM FOR PRODUCTION DATA
PROCESSING

- COMMERCIAL SYSTEM (TOTAL) CAN
PROBABLY BE USED AS A BASE

- WELL HISTORY

- INPUT DATA, OUTPUT DATA FOR GRIDS

- UPDATE CAPABILITY, PREDICTED
WITH ACTUAL

- CORRELATION AND INTERPOLATION
ACROSS GRID POINTS

- POSSIBLY INTERFACE CONTOURING
ROUTINES

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- RECOMMENDATIONS

- PRODUCTION

- . COMPUTER SYSTEMS (Cont.)

- USE FLOATING POINT SYSTEMS ON LOWER
END AT LEAST ON INTERIM BASIS
 - . 64BIT WORD SIZE
 - . DUAL PIPELINE FOR SIMULTANEOUS
32BIT OPERATIONS
 - . DOUBLE PRECISION IN SAME EXECUTION
AS SINGLE
 - . $\frac{1}{2}$ TO 2MB MEMORY
 - . VECTORIZED AND STRUCTURED FORTRAN
 - . FULL MEMORY ADDRESSABILITY

II FINDINGS

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COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION

- MARKET FOR OFFERING GEOPHYSICAL SERVICES IS OUTSTANDING
 - TWO HUNDRED OR MORE PROBABLE CANDIDATES
 - CURRENT U.S. SERVICES MARKET EXCEEDS \$500 MILLION
 - ANNUAL GROWTH RATE OVER NEXT FIVE YEARS EXCEEDS 47%
 - MARKET FOR COMPUTER SYSTEMS FOR SEISMIC APPLICATIONS EXCELLENT
 - ABOUT 100 PETROLEUM AND SEISMIC SERVICES COMPANIES
 - CURRENT U.S. MARKET ON ANNUALIZED LEASE BASIS NEARLY \$600 MILLION
 - FIVE-YEAR ANNUAL GROWTH RATE APPROACHES 45%

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION (Cont.)

- FACTORS INFLUENCING MARKET GROWTH:

- PRICE OF CRUDE PETROLEUM AFFECTING
CASH FLOW OF PRODUCERS

- GROWTH WILL CONTINUE EVEN IF PRICE
INCREASE LEVELS OFF

- SHORTAGE OF QUALIFIED PEOPLE

- EXPLORATION CREWS

- SEISMIC COMPUTER ANALYSTS

- GEOPHYSICISTS

- DRILLING CREWS

- OTHERWISE MARKET WOULD DOUBLE
EACH YEAR THROUGH AT LEAST 1983

- INCREASING QUANTITY OF INPUT DATA

- FORTY-SIX TO 92 TO 1,024 (MARINE)
CHANNEL RECORDING

- INCREASING SAMPLING RATE

- SELECTIVE 3-D DATA ACQUISITION

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COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS
 - EXPLORATION (Cont.)
 - . FACTORS INFLUENCING MARKET GROWTH: (Cont.)
 - IMPROVED TECHNOLOGY REDUCING FRONT
END PROCESSING COSTS
 - . ARRAY PROCESSORS
 - . LARGE SEMICONDUCTOR MEMORIES
 - . HIGH-DENSITY MAGNETIC TAPE
 - INCREASING COMPLEXITY OF PROCESSING,
ANALYSIS AND MODELING SOFTWARE
 - . THREE-DIMENSIONAL
 - . STRATIGRAPHIC ANALYSIS
 - . SYNTHETIC MODELING
 - AUTOMATION OF MAPPING APPLICATIONS
 - . CAD
 - . GRAPHICS
 - . DATA BASE
 - . COLOR PRESENTATION

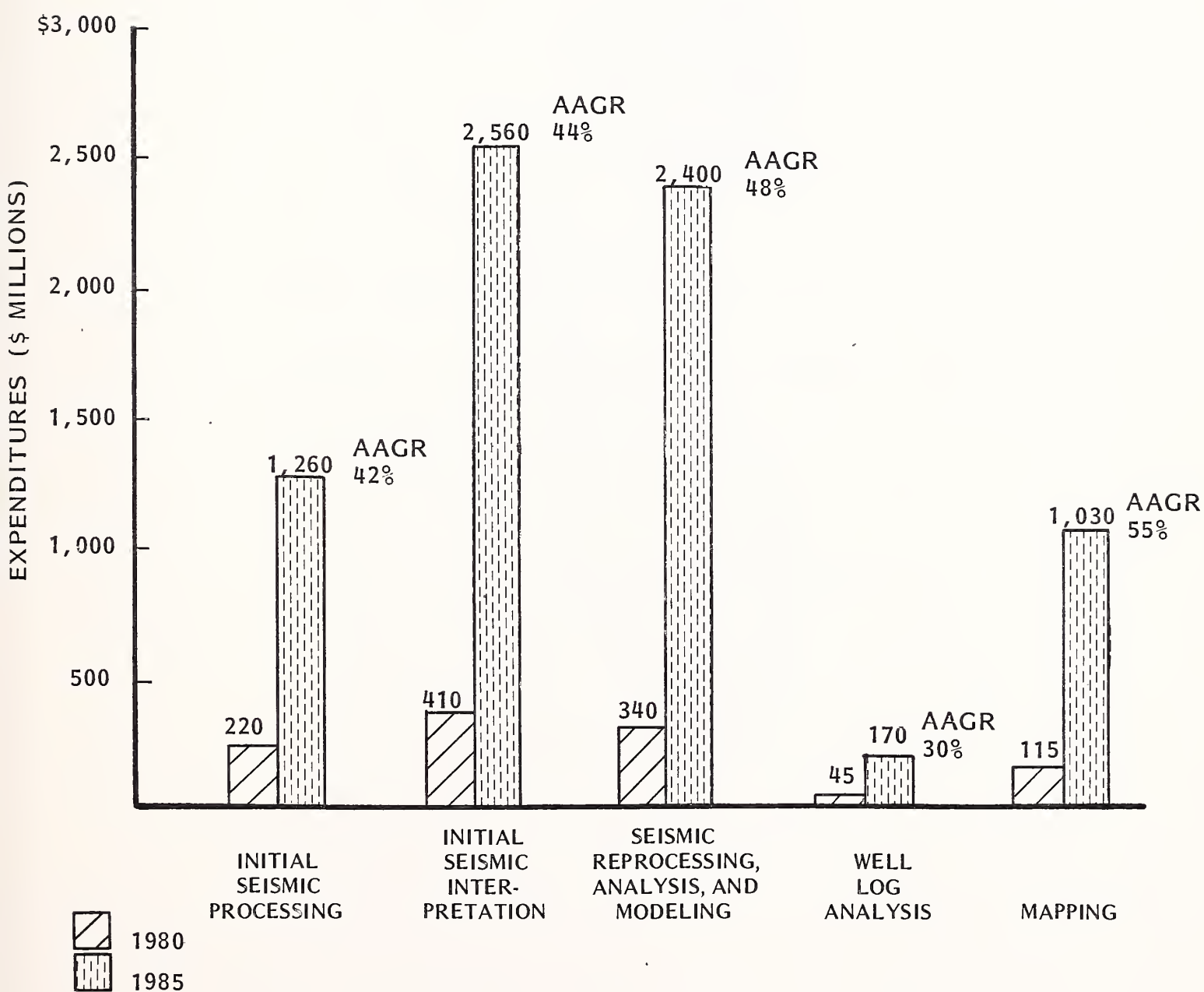
COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

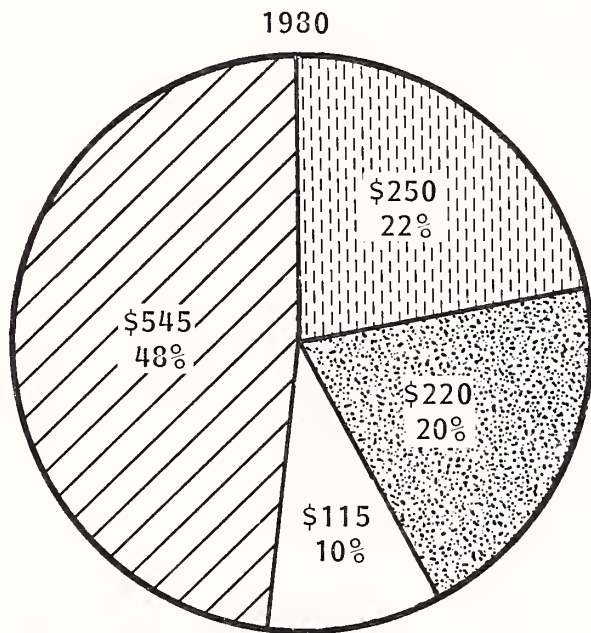
- EXPLORATION (Cont.)

- NINETY PERCENT OF ALL EXPENDITURES ARE BY U.S. PETROLEUM COMPANIES OR ARE PROCESSED BY U.S. COMPANIES
 - ABOUT 25% OF EXPLORATION BUDGETS ARE SPENT FOR GEOPHYSICAL DATA PROCESSING
 - ABOUT 30% OF SEISMIC DATA PROCESSING INVOLVES REPROCESSING THE DATA AT A LATER DATE FOR FURTHER ANALYSIS AND MODELING
 - THE TOP 20 PETROLEUM COMPANIES ACCOUNT FOR 70% OF TOTAL EDP EXPENDITURES FOR EXPLORATION DATA PROCESSING IN 1980
 - THE TOP 20 OIL COMPANIES ARE SHIFTING EXPLORATION DATA PROCESSING TO SERVICE VENDORS
 - FM ARRANGEMENTS FOR DEDICATED CENTERS
 - THE TOP 20 OIL COMPANIES ACCOUNT FOR OVER 50% OF TOTAL COMPUTER SERVICES EXPENDITURES

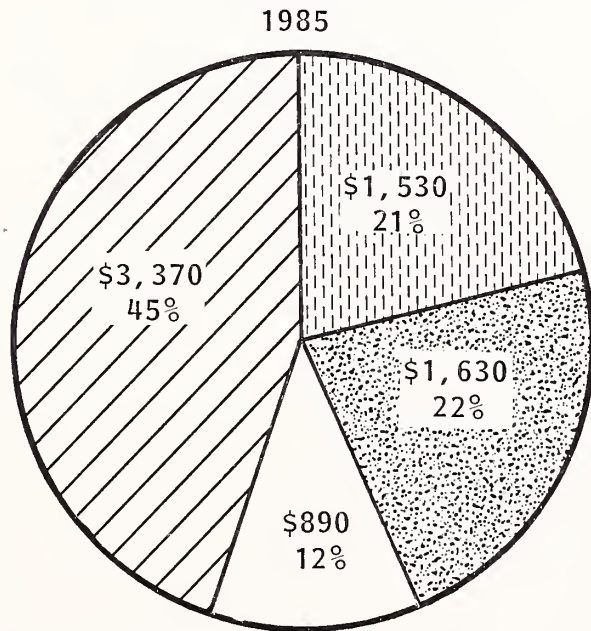
MARKET FORECAST OF EDP EXPENDITURES FOR PETROLEUM EXPLORATION BY APPLICATION, 1980-1985



MARKET FORECAST OF EDP EXPENDITURES
FOR PETROLEUM EXPLORATION BY COMPANY SIZE, 1930-1985







TOTAL \$1,130 MILLION

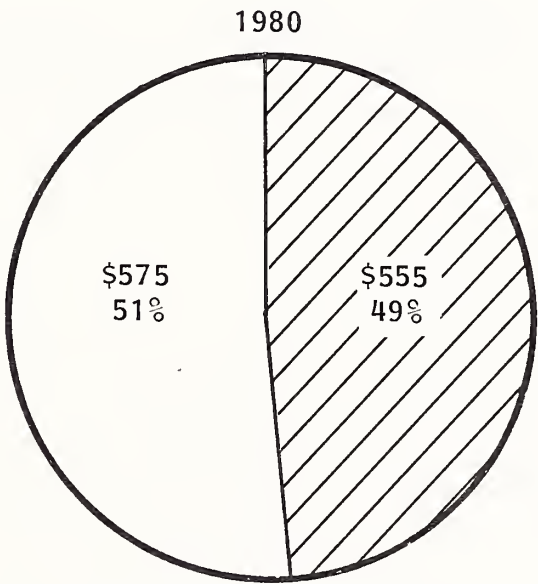


TOTAL \$7,420 MILLION

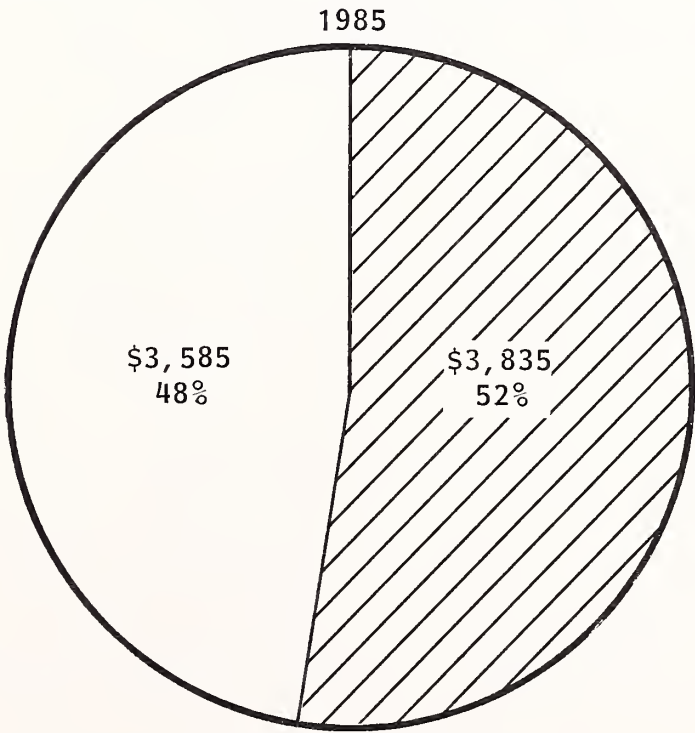
AAGR 46%

-  MAJOR
-  SEMI-MAJOR
-  LARGE INDEPENDENT
-  SMALL INDEPENDENT

MARKET FORECAST OF EDP EXPENDITURES FOR
PETROLEUM EXPLORATION BY PROCESSING METHOD, 1980-1985



TOTAL \$1,130 MILLION



TOTAL \$7,420 MILLION

☐ IN-HOUSE
☒ COMPUTER SERVICES

AAGR 46%

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

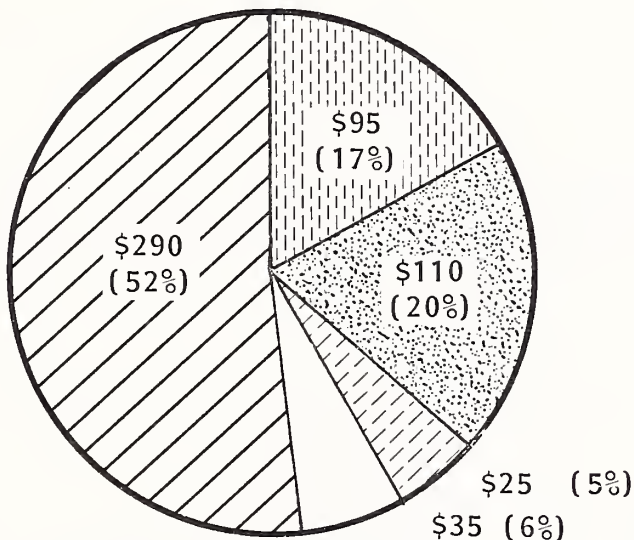
- FINDINGS

- EXPLORATION (Cont.)

- . BATCH IS CURRENTLY THE MAIN MODE OF DELIVERY ACCOUNTING FOR OVER 50% OF TOTAL 1980 EXPENDITURES FOR COMPUTER SERVICES
 - . FM IS A VIABLE MARKET, AGAIN MOSTLY BATCH, AT 20%
 - WILL RISE TO 32% OF MARKET BY 1985
 - . THE MARKET IS SHIFTING FROM BATCH TO REMOTE COMPUTING, 33% BY 1985
 - REMOTE BATCH - 15%
 - INTERACTIVE - 12%
 - DATA BASE SERVICES - 6%

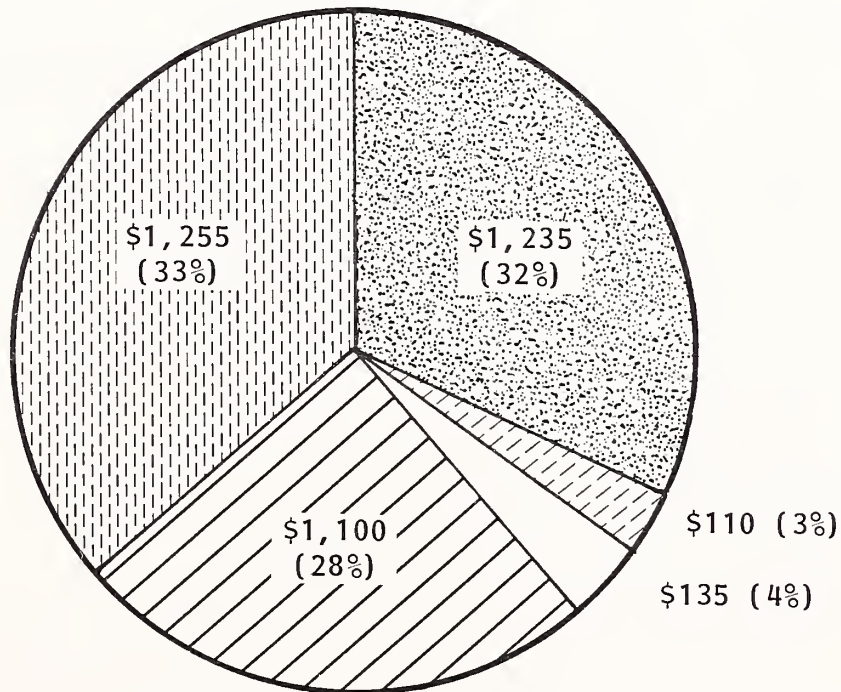
MARKET FORECAST OF COMPUTER SERVICES EXPENDITURES
FOR PETROLEUM EXPLORATION
BY DELIVERY MODE, 1980-1985

1980








TOTAL \$555 MILLION

1985



TOTAL \$3,835 MILLION

AAGR 47%

-  BATCH
-  REMOTE COMPUTER
-  FACILITIES MANAGEMENT
-  SOFTWARE PRODUCTS
-  PROFESSIONAL SERVICES

VENDOR SHARE OF THE UNITED STATES SEISMIC
DATA PROCESSING SERVICES MARKET IN 1980

VENDOR	SEISMIC PROCESSING REVENUES (\$ million)	MARKET SHARE (percent)
WESTERN GEOPHYSICAL (LITTON)	\$ 90	18%
GEOPHYSICAL SERVICES INC (TI)	85	17
GEOSOURCE INC.	75	16
GEODIGIT (CGG)	55	11
SEISMOGRAPHIC SERVICES INC. (RAYTHEON)	35	7
DIGICON INC.	25	5
SEISCON DELTA INC.	20	4
OTHERS	110	22
TOTAL	\$495	100%

COMPUTER SERVICES OPPORTUNITIES IN
PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION (Cont.)

- RESPONDENTS' CURRENT METHODS OF HANDLING SEISMIC INPUT ARE:
 - VIRTUALLY ALL DELIVER TAPES TO PROCESSING CENTER
 - SOME MAJORS AND LARGE INDEPENDENTS USE 9600 BAUD LINES TO TRANSMIT SELECTED DATA
 - RESPONDENTS' CURRENT METHODS OF HANDLING SEISMIC OUTPUT ARE:
 - VIRTUALLY ALL PICKUP OR HAVE DELIVERED SEISMIC SECTIONS
 - SOME USE REMOTE TERMINALS, PLOTTERS AND PRINTERS USING 4800 TO 9600 BAUD LINES
 - SOME MAJORS AND SEMI-MAJORS ARE INTERESTED IN 56 KILO BAUD AND HIGHER SATELLITE LINES FOR SEISMIC INPUT /GRAPHIC OUTPUT TRANSMISSION

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION (Cont.)
 - . RESPONDENTS REPORTED NO INTEREST IN SHIFTING TO AN IN-HOUSE MAINFRAME
 - . RESPONDENTS SHIFTING TO IN-HOUSE MINICOMPUTERS DID SO FOR:
 - UPGRADING FROM 16BIT BATCH SEISMIC PROCESSORS
 - TO OBTAIN IMPROVED SEISMIC SOFTWARE THAT WORKS
 - TO OBTAIN A MULTITASKING OPERATING SYSTEM
 - TO OPERATE IN A VIRTUAL MEMORY ENVIRONMENT
 - TO OBTAIN CRT TERMINALS FOR REMOTE BATCH AND FUTURE INTERACTIVE OPERATION
 - . RESPONDENTS SHIFTING TO IN-HOUSE WERE WILLING TO SPEND BETWEEN \$3/4 AND \$1½ MILLION FOR SYSTEM INCLUDING HARDWARE AND SOFTWARE
 - . UPWARD COMPATIBILITY WAS NOT A MAJOR CONCERN
 - NEAR TERM ONE TO TWO YEAR SOLUTIONS WERE TOP PRIORITY
 - GROWTH BY A FACTOR OF TWO TO THREE SUFFICIENT TO HANDLE CURRENT HORIZON

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION (Cont.)

- MEGA-MINICOMPUTER ARE IMPACTING THE MARKETPLACE
 - DIGICON, SSI AND WESTERN ARE USING THE VAX
 - SEISCON DELTA AND DENVER PROCESSING ARE USING THE SEL
 - AMOCO IS USING PERKIN-ELMER
 - IBM RESPONSE IS 4341 WITH ARRAY PROCESSORS
 - JOINT MARKETING AGREEMENT WITH FLOATING POINT SYSTEMS
 - EIGHTY PERCENT OF PETROLEUM AND SERVICE COMPANIES INTERVIEWED HAVING SEISMIC PROCESSING CAPABILITY HAVE OR PLAN TO INSTALL MEGA-MINIS
 - 2 OF 3 MAJORS
 - 4 OF 4 SEMI MAJORS
 - 2 OF 2 LARGE INDEPENDENTS
 - 0 OF 2 SMALL INDEPENDENTS
 - 4 OF 5 SEISMIC SERVICES COMPANIES

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COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION (Cont.)

- DIGICON DEC VAX SYSTEM SETTING THE TREND

- TYPICAL SYSTEM

- VAX 11/780 PROCESSOR

- EIGHT HIGH-DENSITY
TAPES

- ONE ELECTROSTATIC
PLOTTER

- ONE HIGH-SPEED
PRINTER

- FOUR MB MEMORY

- 600 MB DISK

- TWENTY CRTs

- DIGICON INTERFACES

- TWO FPS ARRAY
PROCESSORS

- DIGICON SEISMIC
SOFTWARE

\$3/4 MILLION

\$1/4 MILLION

- CDC CYBER 730 TWO TIMES THE COST OF VAX

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COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION

- . DIGICON (Cont.)

- VAX OPERATING SYSTEM

- . PROVEN PRODUCT
 - . MULTITASKING CAPABILITY
 - . VIRTUAL MEMORY ALLOCATION

- SHIPMENTS

- . TWO IN FIRST HALF 1980
 - . NINE IN SECOND HALF 1980
 - . TWENTY MORE BY JUNE, 1981

- UPWARD COMPATIBILITY BY A FACTOR OF FOUR

- . EIGHT MB MEMORY
 - . TWO LINKED CPU_s
 - . FOUR ENHANCED FPS ARRAY PROCESSORS

- DIGICON'S MAIN PROBLEMS ARE:

- . MEETING DELIVERY SCHEDULES
 - . FIELD MAINTENANCE

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COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION (Cont.)

- MAJOR AND SEMI-MAJOR PETROLEUM COMPANIES DISTRIBUTING EXPLORATION DATA PROCESSING

- CHEVRON (IBM 4341/VAX)
 - TENNECO (VAX)
 - SOHIO (VAX)
 - BRITISH PETROLEUM (VAX)
 - AMOCO (PERKIN-ELMER)
 - UNION (VAX)

- PETROLEUM COMPANIES CONTRACT A PORTION OF THEIR EXPLORATION:

- FOR SPECIALIZED PROCESSING
 - TO COMPARE RESULTS FROM DIFFERENT APPROACHES
 - TO KEEP UP WITH STATE OF THE ART

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION (Cont.)

- THERE IS LITTLE CURRENT INTEREST ON THE PART OF EXPLORATION GEOPHYSICISTS IN USING SEISMIC SERVICES ON AN RCS BASIS
 - RESOURCES ARE NOT ENOUGH!
 - APPROXIMATELY 10% OF INDEPENDENTS INTERVIEWED EXPRESSED INTEREST
 - RESPONDENTS WANTED A TOTAL SERVICE, INCLUDING SOFTWARE AND CONSULTING AT THE PROCESSING CENTER FOR SEISMIC DATA ANALYSIS AND PROCESSING
 - RESPONDENTS WERE MOST INTERESTED IN REMOTE INTERACTIVE SEISMIC PROCESSING FOR:
 - STRATIGRAPHIC ANALYSIS
 - SEISMIC MODELING
 - THERE IS LOW IMMEDIATE INTEREST IN 3-D PROCESSING ALGORITHMS

PREFERRED ANALYSIS SYSTEM FUNCTIONS
AS REPORTED BY RESPONDENTS

FUNCTION	RATING
WAVELLET ANALYSIS	7.0
TIME-SERIES ANALYSIS	2.2
FREQUENCY WAVELETT ANALYSIS	3.2
STRATIGRAPHIC ANALYSIS	8.0
STRUCTURAL ANALYSIS	7.3
3-D PROCESSING ALGORITHMS	3.3
FOURIER TRANSFORMS	4.0
MIGRATION ANALYSIS	7.3
SEISMIC MODELING	7.7

ON A SCALE OF 10 TO 1 WHERE 10 = MOST IMPORTANT,
7 = VERY IMPORTANT, 4 = IMPORTANT, 1 = NOT IMPORTANT

NUMBER OF RESPONDENTS = 9

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS (Cont.)

- EXPLORATION

- OTHER SEISMIC ANALYSIS FUNCTIONS OF
HIGH INTEREST TO RESPONDENTS ARE:

- DATA INTERPOLATION
 - WELL LOG MODELING
 - TRACE ATTRIBUTE PROCESSING

- RESPONDENTS WANT INTELLIGENCE IN REMOTE
GRAPHIC TERMINALS

- DID NOT DISTINGUISH BETWEEN MICRO-
BASED TERMINAL VERSUS MINI-BASED
WORKSTATION
 - COLOR THE TREND BUT NOT A MUST
FOR INITIAL OFFERING
 - MAJORS WILLING TO PAY IN EXCESS OF
\$100 THOUSAND EACH FOR RIGHT
GRAPHICS SYSTEM

- OTHER CHARACTERISTICS OF IMPORTANCE ARE:

- STORAGE TYPE WITH REFRESH
 - DOT MATRIX FOR ELECTROSTATIC
PLOTTERS - GEOSOURCE
 - HIGH-RESOLUTION CRTs
 - FLEXIBLE GRAPHICS SOFTWARE

REMOTE GRAPHICS TERMINAL CHARACTERISTICS
AS REPORTED BY RESPONDENTS

CHARACTERISTIC	PORTION WANTING (PERCENT)	
PEN PLOTTER	46%	
ELECTROSTATIC PLOTTER	100	
COLOR CRT	38	
	PRICE RANGE PURCHASE (\$ THOUSAND)	AVERAGE PURCHASE PRICE (\$ THOUSAND)
NO COLOR	\$25-45	\$40
COLOR	40-120	70

NUMBER OF RESPONDENTS = 13

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION (Cont.)

- DATA MANAGEMENT AND DATA BASE MANAGEMENT SYSTEMS WERE FOUND EQUALLY IMPORTANT TO RESPONDENTS
 - CURRENTLY MAJORS ARE PRIME USERS
 - MOST CURRENT SYSTEMS ARE DATA MANAGEMENT ORIENTED
 - SEISMIC DP USERS JUST GETTING INTO DBMS
 - DBMS ESSENTIAL FOR COMPUTER AIDED MAPPING APPLICATIONS
 - SHORTAGE OF QUALIFIED DBMS SYSTEM SOFTWARE TYPES IN GEOPHYSICAL DATA PROCESSING

IMPORTANCE OF DATA MANAGEMENT /
DATA BASE SERVICES BY COMPANY SIZE
AS REPORTED BY RESPONDENTS

COMPANY SIZE	SAMPLE SIZE	PORTION USING DMS /DBMS (PERCENT)	IMPORTANCE OF*	
			DMS	DBMS
MAJOR	2	100%	7.0	8.0
SEMI-MAJOR	4	100	6.5	8.0
LARGE INDEPENDENT	7	29	8.0	6.0
SMALL INDEPENDENT	5	0	7.2	7.2
SEISMIC PROCESSING COMPANIES	5	40	7.0	6.8
CONSULTANTS	2	50	7.0	8.0
TOTAL	25	40%	7.1	7.2

*ON SCALE OF 10 TO 1

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION (Cont.)

- LOW CURRENT INTEREST ON PETROLEUM
COMPANY RESPONDENTS' PART FOR "OTHER"
DATA BASE SERVICES

- WELL HISTORY AND LEASE STATUS ARE
DATA BASES OF SOME INTEREST

- SECURITY IS NOT A MAJOR CONCERN OF
EITHER USERS OR VENDORS OF RCS FOR
SEISMIC DATA

- DIGICON IS PLANNING TO PROVIDE DATA
ENCRYPTION FOR LINES CONNECTED TO
REMOTE TERMINALS

ATTITUDES TOWARD SECURITY AS
A CONCERN FOR RCS SEISMIC SERVICES
AS REPORTED BY RESPONDENTS

TYPE	SAMPLE SIZE	PORTION CONCERNED (PERCENT)
PETROLEUM COMPANY	15	27%
SERVICES COMPANY	4	25
TOTAL	19	26%

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION (Cont.)

- . IN UPGRADING OR PROCURING NEW MAINFRAME
 - SERVICE COMPANIES AND INDEPENDENTS INTERVIEWED WERE MEGA-MINI ORIENTED
 - MAJORS WERE SHIFTING TO DISTRIBUTED PROCESSING
 - . UPWARD COMPATIBILITY NOT A MAJOR ISSUE IN THE NEAR TERM
 - THROUGHPUT INCREASES BY A FACTOR OF FOUR WITHIN CAPABILITY OF MEGA-MINIS
 - SHIFT TO NEW OPERATING SYSTEMS OF GREATER CONCERN THAN FORTRAN APPLICATION PROGRAMS
 - PRIMARY CONCERN OF MAJORS IS SHIFTING OR OFFLOADING FROM IBM MAINFRAMES
 - . IN LONGER TERM MAJORS LOOKING TO SUPER-COMPUTERS TO HANDLE 3-D PROCESSING
 - CRAY-1s OR CYBER 205
 - "MEGA-MINIS ARE INTERIM SOLUTION UNTIL NEW IBM NETWORK SYSTEMS AVAILABLE"

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION (Cont.)

- SEISMIC SOFTWARE AVAILABILITY A MAJOR CONCERN TO SEMI-MAJORS AND LARGE INDEPENDENTS

- UNION

- TENNECO

- WITH RESPECT TO FLOATING POINT WORD SIZE:

- IN THE NEAR TERM 32BIT SUFFICIENT

- WITH 3-D PROCESSING

- 32BITS NOT ENOUGH IN MOST INSTANCES

- 36-40BITS SUFFICIENT

- 60BITS FAR TOO MANY

- WITH RESPECT TO VECTOR PROCESSING:

- IN THE NEAR TERM NO ADVANTAGE OF VECTOR OVER SCALAR FOR SEISMIC PROCESSING

- SPECIAL PURPOSE PROCESSING THROUGH MULTIPLE ARRAY PROCESSORS IS MOST COST EFFECTIVE

- IN 3-5 YEARS WITH 3-D PROCESSING VECTOR ARITHMETIC MAY BECOME MORE IMPORTANT

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- EXPLORATION (Cont.)

- . WITH RESPECT TO ADVANCED ARRAY PROCESSORS

- 64BIT WORD SIZE
 - DUAL PIPELINES TO SIMULTANEOUS 32BIT FP OPERATIONS
 - DOUBLE PRECISION IN SAME EXECUTION TIME AS SINGLE
 - STRUCTURED FORTRAN PROGRAMMABILITY
 - $\frac{1}{2}$ INCREMENTALLY TO 2MB MEMORY
 - FULL MEMORY ADDRESSABILITY

- . CPU MEMORY SIZE IS ALSO IMPORTANT

- 1MB MINIMUM
 - GROWTH AND ADDRESSABILITY TO AT LEAST 4MB
 - VIRTUAL MEMORY ADDRESSABILITY TO 64MB

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- PRODUCTION

- . MARKET FOR OFFERING PETROLEUM RESERVOIR
SIMULATION SERVICES IS EXCELLENT

- ABOUT 100 PROBABLE U.S. CANDIDATES
 - CURRENT U.S. SERVICES MARKET IS \$60
MILLION
 - ANNUAL GROWTH RATE OVER THE NEXT
FIVE YEARS IS 30%

- . MARKET FOR COMPUTER SYSTEMS FOR PRO-
DUCTION APPLICATIONS IS EXCELLENT

- ABOUT 30 PROBABLE CANDIDATES
 - CURRENT U.S. MARKET ON ANNUALIZED
LEASE BASIS IS NEARLY \$60 MILLION
 - FIVE-YEAR ANNUAL GROWTH RATE
IS NEARLY 32%

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- PRODUCTION (Cont.)

- . FACTORS INFLUENCING MARKET GROWTH ARE:

- PRICE OF CRUDE PETROLEUM
 - . LARGE BLACK OIL FIELD PRODUCTION PLANNING
 - . ENHANCED RECOVERY FROM EXISTING SMALLER FIELDS
 - . DEEPER DRILLING
 - DECONTROL OF PETROLEUM IN THE U.S.
 - SHORTAGE OF QUALIFIED PEOPLE
 - . RESERVOIR SIMULATION ENGINEERS
 - . COMPUTER MATHEMATICAL ANALYSTS
 - MANAGEMENT APPRECIATION OF COST / EFFECTIVENESS OF RESERVOIR ENGINEERING ANALYTICS
 - REDUCTION IN PRODUCTION COSTS OF VERY LARGE-SCALE VECTOR COMPUTERS

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

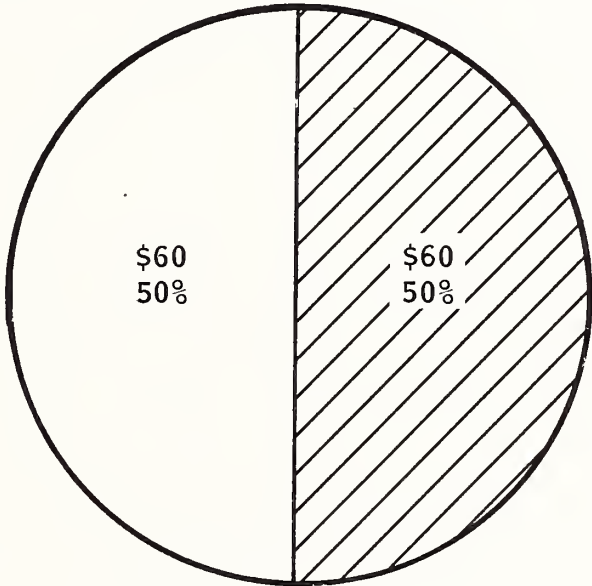
- FINDINGS

- PRODUCTION (Cont.)

- THE EIGHT MAJORS CURRENTLY ACCOUNT FOR OVER 70% OF ALL RESERVOIR SIMULATION
 - THE TOP 20 COMPANIES PROBABLY ACCOUNT FOR 90% OF ALL ACTIVITY
 - ABOUT 80% OF ALL SERVICES ARE FOR U.S. COMPANIES
 - INCLUDES WORK DONE IN U.S. ON BEHALF OF FOREIGN GOVERNMENTS AND NATIONAL OIL COMPANIES
 - 1980 EDP EXPENDITURES FOR RESERVOIR SIMULATION MODELING IN THE U.S. WERE \$120 MILLION
 - AS IF ALL WERE DONE AT COMPUTER SERVICES COMPANY RATES
 - ON ANNUALIZED LEASE BASIS
 - THE MAJORS ARE MOVING MORE IN-HOUSE, MORE THAN OFFSETTING NEW USE BY BY INDEPENDENTS

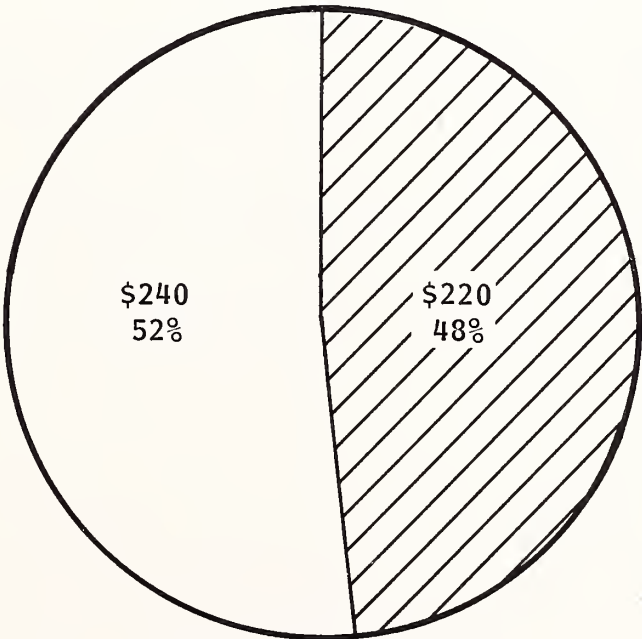
MARKET FORECAST OF EDP EXPENDITURES FOR
RESERVOIR SIMULATION BY PROCESSING METHOD, 1980-1985

1980



TOTAL \$120 MILLION

1985



TOTAL \$460 MILLION

AAGR 31%

- ☐ IN-HOUSE
- ☒ COMPUTER SERVICES

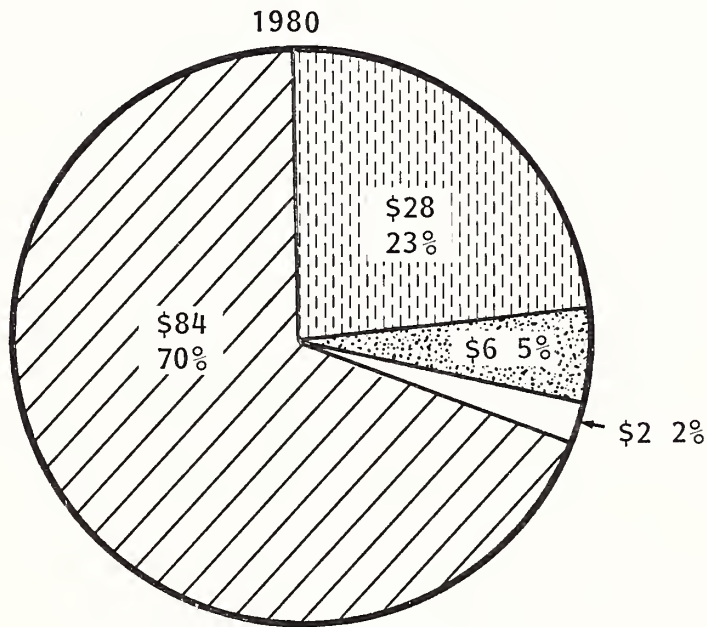
COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

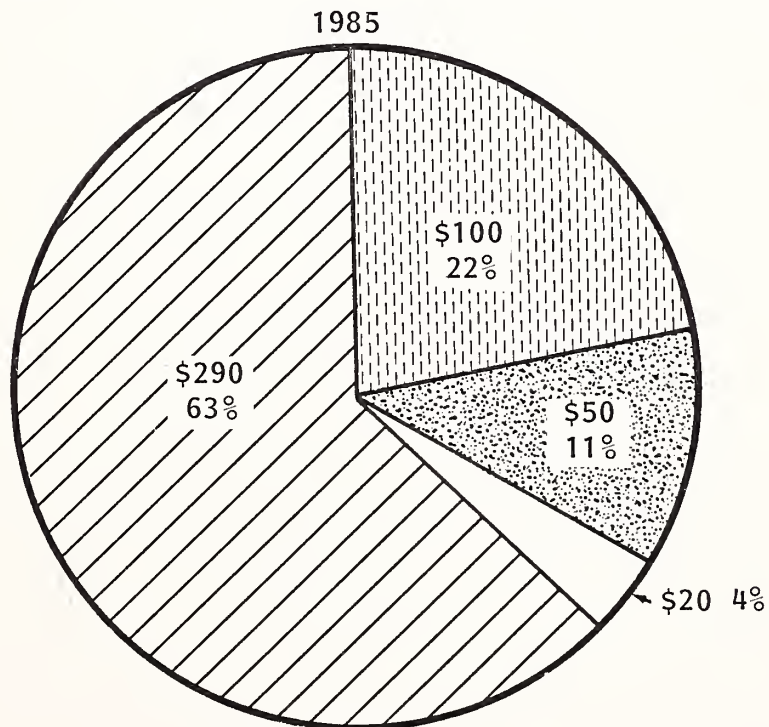
- PRODUCTION (Cont.)

- THE ACTION IS AND WILL REMAIN WITH THE EIGHT MAJORS
 - \$84 MILLION OR 70% IN 1980
 - \$290 MILLION OR 63% IN 1985
 - THE MAJOR PORTION OF THE REMAINDER IS WITH THE SEMI-MAJORS
 - TOGETHER WITH THE MAJORS REPRESENT 90% OF THE MARKET
 - HOWEVER THE PORTION INDEPENDENTS SPEND WILL GROW BY A FACTOR OF NINE TO 15% OF TOTAL EXPENDITURES BY 1985
 - HALF OF THE CURRENT MARKET IS FOR COMPUTER SYSTEMS USED IN-HOUSE
 - PROJECTED MARKET FOR 1985 IS \$240 MILLION ON ANNUALIZED LEASE BASIS





MARKET FORECAST OF EDP EXPENDITURES
FOR PETROLEUM RESERVOIR SIMULATION
BY COMPANY SIZE, 1980-1985



TOTAL \$120 MILLION



TOTAL \$460 MILLION
AAGR 31%

-  MAJOR
-  SEMI-MAJOR
-  LARGE INDEPENDENT
-  SMALL INDEPENDENT

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- PRODUCTION (Cont.)

- REMOTE COMPUTING SERVICES THE
MAJOR DELIVERY MODE

- REMOTE BATCH 47%

- INTERACTIVE 11%

- USE OF INTERACTIVE SERVICES INCREASING

- PREPROCESSING DATA AND PARAMETER
PREPARATION

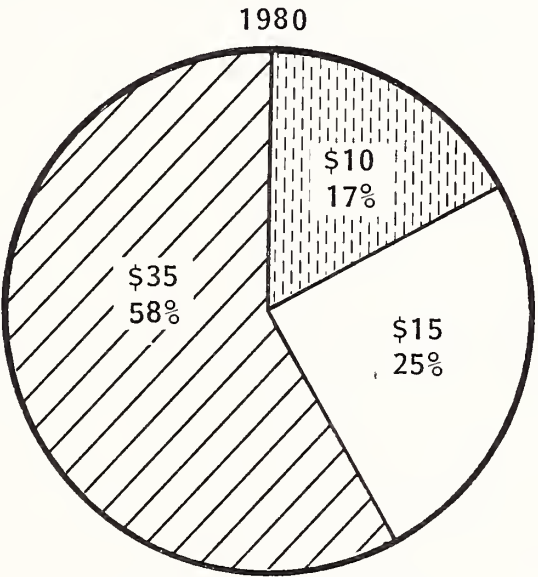
- POSTPROCESSING ANALYSIS AND
GRAPHICS

- SOFTWARE PRODUCTS AND PROFESSIONAL
SERVICES A SIGNIFICANT COMPONENT

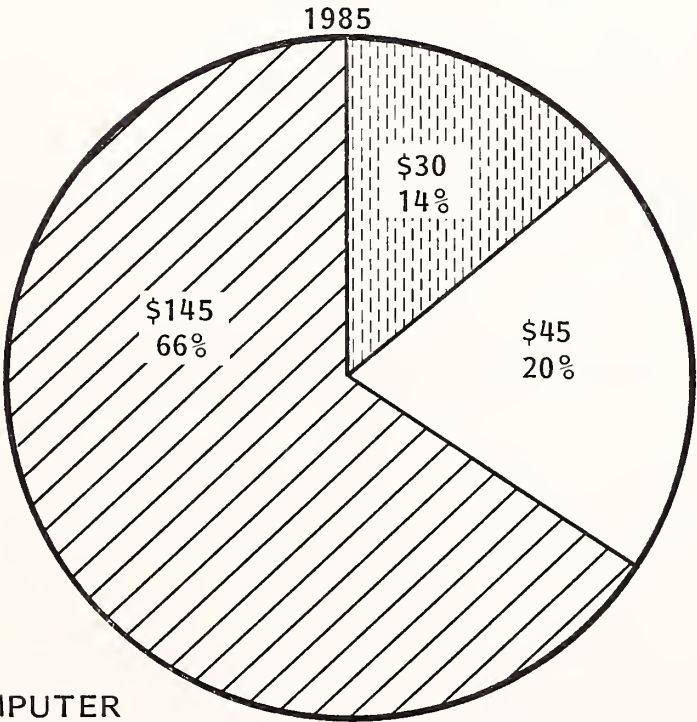
- SOFTWARE PRODUCTS 17%

- PROFESSIONAL SERVICES 25%

MARKET FORECAST OF COMPUTER SERVICES EXPENDITURES
FOR PETROLEUM RESERVOIR SIMULATION
BY DELIVERY MODE, 1980-1985






TOTAL \$60 MILLION



TOTAL \$220 MILLION

AAGR 30%

-  REMOTE COMPUTER SERVICES
-  SOFTWARE PRODUCTS
-  PROFESSIONAL SERVICES

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- PRODUCTION (Cont.)

- MAJORS IN PROCESS OF SELECTING SUPER-COMPUTERS FOR RESERVOIR SIMULATION

- EXXON - CRAY-1 IN 1981
 - SOHIO - CYBER 205 IN 1981/1982
 - CHEVRON - CYBER/CRAY IN 1981/1982
 - AMOCO - CYBER/CRAY IN 1981
 - UNION - CYBER/CRAY IN 1982/1983
 - MOBIL - CYBER/CRAY IN 1981/1982

- IBM 3000 SERIES INADEQUATE TO HANDLE THE PROBLEM

- ARRAY PROCESSOR OBSOLETE
 - JOINT MARKETING AGREEMENT WITH FLOATING POINT SYSTEMS

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- PRODUCTION (Cont.)

- RESPONDENTS USE OUTSIDE RCS SERVICES FOR RESERVOIR MODELING
 - ON AN INTERIM BASIS
 - REMOTE BATCH RESOURCES TO MAJORS
 - THROUGH CONSULTANTS FOR SEMI-MAJORS AND SELECTED LARGE INDEPENDENTS
 - SOFTWARE PRODUCT AND CONSULTING SERVICES A MUST
 - WITH RESPECT TO UPGRADING MAINFRAMES:
 - UPWARD COMPATIBILITY IS NOT THE ISSUE
 - TRANSFERABILITY FROM IBM MAINFRAMES IS
 - 3-D BLACK OIL AND ENHANCED RECOVERY MODELS FOR MAJORS REQUIRE SUPER COMPUTERS
 - A WIDE GAP BETWEEN IBM/CDC/UNIVAC MAINFRAMES AND SUPERCOMPUTERS
 - MAJORS AND SEMI-MAJORS ARE PLANNING TO BUY MAINFRAMES TO DO RESERVOIR MODELING
 - RCS CAN SUPPLY RESOURCES IN THE INTERIM
 - FOR COMPUTER SERVICES, MODELS AND CONSULTING REQUIRED FOR SEMI-MAJORS AND LARGE INDEPENDENTS

INPUT
Y-PET R49

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- PRODUCTION (Cont.)

- . VECTOR ARCHITECTURE IS A MUST :

- ALSO ABILITY TO HANDLE SCALAR PORTION EFFICIENTLY
 - 30-40% OF REMAINING CODE IS SCALAR
 - TREND IS FOR CLOSELY COUPLED SOLUTIONS

- . CHARACTERISTICS OF CLOSELY COUPLED SYSTEMS ARE:

- REQUIRE LARGER MEMORY (3-4MB)
 - REQUIRE GREATER PRECISION FOR SIMULTANEOUS SOLUTIONS

- . INSTABILITY (64BITS)

- GET GREATER EFFICIENCY THROUGH VECTORIZATION (FACTOR 5-10)
 - REQUIRE FEWER TIME STEPS

- . MEMORY SIZE AN IMPORTANT CONSIDERATION:

- 4MB JUST AS IMPORTANT AS ARITHMETIC SPEED

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- PRODUCTION (Cont.)

- . VIRTUAL MEMORY OPERATING SYSTEM A MUST

- VIRTUAL SYSTEM A MATTER OF ENGINEERING ANALYSIS/PROGRAMMING RESOURCES
 - NECESSARY FOR DEVELOPMENT
 - CAN BE WASTEFUL IF SYSTEM NOT PROPERLY UNDERSTOOD
 - 32-64MB VIRTUAL SYSTEM

- . TO PROPERLY VECTORIZE RESERVOIR PROBLEMS NEED NEW QUANTITATIVE ANALYSIS TECHNIQUES

- BALANCE ANALYSIS/PROGRAMMER PRODUCTIVITY WITH SUPERCOMPUTER EFFICIENCY
 - CLOSER COUPLING OF FORTRAN VECTORIZING AND OPTIMIZING COMPILERS TO SUPERCOMPUTER ARCHITECTURES

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- PRODUCTION (Cont.)

- WITH RESPECT TO FLOATING POINT WORD SIZE:

- A QUESTION OF ENGINEERING ANALYSIS/
PROGRAMMING RESOURCES
 - 32BITS SUFFICIENT FOR 80% OF PROBLEMS
USING 20% OF RESOURCES
 - LOOSELY COUPLED IMPLICIT SYSTEMS
(IMPRESS)
 - ERROR ANALYSIS FOR DOUBLE PRECISION
FREQUENTLY NECESSARY FOR EVERY RUN
DEPENDING ON MODEL SIZE
 - 60BITS COST-EFFECTIVE WAY TO GO
 - 20% OF PROBLEMS USE 80% OF RESOURCES
 - CLOSELY COUPLED EXPLICIT SYSTEMS
MORE UNSTABLE

- WITH RESPECT TO ATTACHED PROCESSORS

- FAVORED BY TWO RESPONDENTS
 - 64BIT WORD SIZE
 - DUAL PIPELINES FOR SIMULTANEOUS
32BIT FP OPERATIONS
 - DOUBLE PRECISION IN SAME EXECUTION
TIME AS SINGLE
 - 0.5-2MB MEMORY
 - VECTORIZED FORTRAN PROGRAMMABILITY
 - FULL MEMORY ADDRESSABILITY

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- PRODUCTION (Cont.)

- CROSSOVER POINT WHEN PETROLEUM RESERVOIR PROBLEM CANNOT BE HANDLED ON STATE OF ART LARGE MAINFRAME

- 3,000 TO 5,000 GRID POINTS
 - 2-3 LAYERS
 - 10-20 EQUATIONS
 - LESS THAN TEN YEARS FORWARD
 - RUNS UP TO EIGHT HOURS CLOCKTIME
 - CHECK POINT-RESTART CAN MAKE TURNAROUND BECOME DAYS

- TREND FOR MAJORS IS TOWARD LARGER AND MORE COMPLEX PROBLEMS

- 30,000 WIDELY SEPARATED GRID POINTS ON LARGE FIELD
 - DEEPER WELLS REQUIRING MORE LAYERS
 - COMPOSITIONAL MODELING
 - ENHANCED RECOVERY INCREASES COMPUTATIONAL REQUIREMENTS BY A FACTOR OF 5-10

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- PRODUCTION (Cont.)

- THE MARKET FOR INDEPENDENTS IS WITH SMALLER FIELDS AND WITH ENHANCED RECOVERY
 - 300-400 GRID POINTS
 - 1-2 LAYERS
 - COUPLED WITH ECONOMIC MODELING
 - 80% CAN BE HANDLED BY MEGA-MINIS
 - DATA BASE MANAGEMENT SYSTEMS NOT YET IN USE BUT COMING
 - MODEL BUILDERS ARE IN PRODUCTION RESEARCH ORGANIZATIONS
 - RESERVOIR ENGINEER GATHERS AND VALIDATES DATA FILES
 - INTERACTIVE TERMINALS OPERATING ON REMOTE BATCH DATA FILES
 - 100,000 DATA ITEMS
 - MAJORS LOOKING INTO DBMS SYSTEMS FOR PRODUCTION PLANNING
 - UPDATE PREDICTED WITH ACTUAL DATA OVER TIME
 - PULL VALIDATED DATA FROM HISTORY DATA BASE FOR RESERVOIR STUDIES
 - CORRELATION AND INTERPOLATION ACROSS GRID POINTS
 - APPLY CONTOURING SOFTWARE TO PRE- AND POST-PROCESSING GRID DATA POINTS

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- PRODUCTION (Cont.)

- RESPONDENTS FIND IT EASIER TO SHIFT FROM
IBM TO CRAY THAN TO CYBER

- CRAY FORTRAN MAKES BETTER USE
OF MAINFRAME RESOURCES
 - SCALAR RUNS FASTER ON CRAY THAN
CYBER
 - CRAY FORTRAN IV MORE COMPATIBLE
WITH IBM FORTRAN IV THAN CYBER
 - CRAY OPERATING SYSTEM MORE END
USER ORIENTED THAN CYBER

- PROBLEMS CITED WITH CYBER SOFTWARE WERE :

- MEDIOCRE FORTRAN COMPILER VECTORIZATION
 - POOR FORTRAN OPTIMIZATION OF CYBER 205
MACHINE RESOURCES
 - OPERATING SYSTEM TOO ENGINEERING
PROGRAMMER ORIENTED
 - LACKS VIRTUAL CAPABILITY
 - HASP MODE FOR REMOTE PROCESSING
INADEQUATE
 - NEED HIGH-SPEED ASYNC COMMUNICATIONS
 - SYSTEMS UTILITIES
 - SORTS MAKE POOR USE OF RESOURCES
 - NOT USER FRIENDLY

COMPUTER SERVICES OPPORTUNITIES IN PETROLEUM EXPLORATION AND PRODUCTION

- FINDINGS

- PRODUCTION (Cont.)

- RESPONDENTS REPORT EQUIVALENT CRAY
SYSTEM LESS EXPENSIVE

- \$15 MILLION FOR CYBER 205 WITH
CYBER 170 SERIES FRONT END

- \$12 MILLION FOR CRAY 1-S WITH
IBM 3033 FRONT END

- IF PRODUCTION COSTS REDUCE PRICE TO
\$7-9 MILLION RANGE WILL OPEN MARKET
FOR SEMI-MAJORS, SELECTED LARGE INDE-
PENDENTS, AND FOREIGN NATIONAL
OIL COMPANIES

III MARKET FORECAST

— INPUT —

MARKET FORECAST

I. EXPLORATION

- First, the market was stratified, as shown in Exhibit 1.
 - Major oil companies, eight in all, range from Exxon with 1980 revenues exceeding \$100 billion to Shell with \$20 billion.
 - Semi-major oil companies (12 in all) range from Conoco with \$18 billion in 1980 revenues to Cities Services exceeding \$7 billion.
 - Large independents, approximately 60 in all, range from Coastal exceeding \$5 billion in 1980 revenues to Soroco at \$500 million.
 - Small independents, counted at 740 from one available data source and 485 from another, could well exceed 2,000. Most of the variance is undoubtedly due to the large number of small companies involved in drilling programs, companies not likely to use geophysical computer services.
- Using the Society of Exploration Geophysicists' (SEG) data on expenditures for geophysical exploration and expert opinion, total worldwide expenditures for initial seismic processing and interpretation were developed for 1979 and 1980, as shown in Exhibit 2.

EXHIBIT I

DISTRIBUTION OF U.S. PETROLEUM COMPANIES BY SIZE IN 1980

COMPANY SIZE	ANNUAL REVENUES (\$ BILLIONS)	NUMBER
MAJOR	>\$20	8
SEMI-MAJOR	\$7-19	12
LARGE INDEPENDENT	\$0.5-6.0	60
SMALL INDEPENDENT	<\$0.5	740
TOTAL	-	820

SOURCE: 1981 U.S.A. OIL INDUSTRY DIRECTORY

NOTE: 565 U.S. AND CANADIAN COMPANIES USING GEOPHYSICAL
TECHNIQUES, THE GEOPHYSICAL DIRECTORY, 1981.

- Total expenditures for initial seismic processing and interpretation in 1980 were approximately \$700 million.
 - Due to the escalating cost of qualified personnel and the impact of inflation on the capital-intensive nature of seismic data acquisition, this geophysical component grew at the highest rate.
 - Initial seismic processing, where improved computer technology is decreasing data reduction costs, is still growing at a rate exceeding 40% annually.
 - Initial seismic interpretation, more labor-intensive than data reduction, hence more inflation rate sensitive, grew at a higher rate, 44%, than seismic processing.
- The data for initial seismic processing and interpretation were derived primarily from processing services vendors. Hence, the forecast that is developed views exploration data processing:
 - On an annualized basis; that is, equipment costs are imputed on an equivalent lease basis.
 - As if all exploration data processing were accomplished by computer services vendors.
 - To the extent that the forecast divides total exploration data processing between in-house and computer services, the forecast may overstate what petroleum companies report they spend on exploration data processing in-house.
 - Expert opinion indicates that currently about 90% of all exploration data processing expenditures are by U.S. petroleum companies or are processed by U.S. services companies. This portion is slowly decreasing and is estimated to be about 85% by 1985.

- Applying \$630 million for initial seismic processing and interpretation, and including the breakdown between processing and interpretation (Exhibit 2) with the distribution of EDP expenditures by application from survey data, as shown in Exhibit 3, it was initially determined that total EDP expenditures for the U.S. market including Canada in 1980 were \$1,130 million.
- Using survey data and expert opinion on growth rates for each application, as shown in Exhibit 4, total EDP expenditures were forecast for 1982 and 1985, as shown in Exhibit 5.
 - Initial interpretation grows faster than initial processing because of the expert labor-intensive nature of interpretation work.
 - Reprocessing, analysis, and modeling grow more rapidly yet because of 3-D work and increased interactive modeling activities.
 - Well log analysis, now field digitized, grows at a moderate rate.
 - The mapping application with increased automation including interactive graphics will experience the greatest growth.
- Using survey data and expert opinion, the portion of total EDP expenditures by company size for each application was determined for 1980 and forecast for 1985, as shown in Exhibit 6.
 - The top 20 (major and semi-major) companies accounted for between 60% and 80% of total EDP expenditures in 1980 depending on application type.
 - The large and small independents are expected to increase EDP expenditures faster than the larger companies over the forecast period, particularly in the reprocessing, analysis and modeling, and mapping applications.

EXHIBIT 2

TOTAL WORLDWIDE EXPENDITURES FOR GEOPHYSICAL EXPLORATION, 1979-1980

ACTIVITY	(\$ BILLIONS)						GROWTH 1979/1980 PERCENT
	LAND		MARINE		TOTAL		
	1979	1980	1979	1980	1979	1980	
SEISMIC DATA ACQUISITION	\$1.21	\$1.80	\$0.26	\$0.42	\$1.49	\$2.22	51%
INITIAL SEISMIC PROCESSING	0.06	0.09	0.11	0.15	0.17	0.24	42
INITIAL SEISMIC INTERPRETATION	0.12	0.17	0.20	0.29	0.32	0.46	44
TOTAL	\$1.39	\$2.06	\$0.57	\$0.86	\$1.96	\$2.92	49%
PORTION INITIAL SEISMIC PROCESSING AND INTERPRETATION	13%	12%	54%	51%	25%	24%	—
SEISMIC LINE MILES	333,650	391,601	565,725	658,474	899,375	1,050,075	17%

SOURCE: SEG SPECIAL REPORTS, GEOPHYSICAL ACTIVITY IN 1979-1980

EXHIBIT 3

DISTRIBUTION OF EDP EXPENDITURES FOR PETROLEUM EXPLORATION BY APPLICATION, 1980-1985

APPLICATION	PORTION (PERCENT)		
	1980	1982	1985
INITIAL SEISMIC PROCESSING	19%	18%	17%
INITIAL SEISMIC INTERPRETATION	37	36	35
SEISMIC REPROCESSING, ANALYSIS, AND MODELING	30	31	32
WELL LOG ANALYSIS	4	3	2
MAPPING	10	12	14
TOTAL	100%	100%	100%

EXHIBIT 4

GROWTH IN EDP EXPENDITURES FOR PETROLEUM EXPLORATION BY APPLICATION, 1979-1985

APPLICATION	AAGR (PERCENT)			AAGR 1980/1985 (PERCENT)
	1980/1979	1982/1980	1985/1982	
INITIAL SEISMIC PROCESSING	41%	45%	40%	42%
INITIAL SEISMIC INTERPRETATION	41	50	41	44
SEISMIC REPROCESSING, ANALYSIS, AND MODELING	41	53	44	48
WELL LOG ANALYSIS	35	33	29	30
MAPPING	40	62	51	55
TOTAL	40%	50%	43%	46%

EXHIBIT 5

TOTAL EDP EXPENDITURES FOR PETROLEUM EXPLORATION BY APPLICATION, 1980-1985

APPLICATION	(\$ MILLIONS)			AAGR 1980/1985 (PERCENT)
	1980	1982	1985	
INITIAL SEISMIC PROCESSING	\$ 220	\$ 460	\$1,260	42%
INITIAL SEISMIC INTERPRETATION	410	920	2,560	44
SEISMIC REPROCESSING, ANALYSIS AND MODELING	340	800	2,400	48
WELL LOG ANALYSIS	45	80	170	30
MAPPING	115	300	1,030	55
TOTAL	\$1,130	\$2,560	\$7,420	46%

DISTRIBUTION OF EDP EXPENDITURES FOR
PETROLEUM EXPLORATION BY COMPANY SIZE IN 1980-1985

COMPANY SIZE	APPLICATION /PORTION (PERCENT)									
	INITIAL SEISMIC PROCESSING		INITIAL SEISMIC INTER- PRETATION		SEISMIC RE- PROCESSING, ANALYSIS, AND MODELING		WELL LOG ANALYSIS		MAPPING	
	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985
MAJOR	45%	42%	45%	42%	50%	45%	40%	40%	60%	50%
SEMI-MAJOR	22	20	22	20	25	22	20	20	20	18
LARGE INDEPEN- DENT	20	23	20	23	20	23	22	22	15	22
SMALL INDEPEN- DENT	13	15	13	15	5	10	18	18	5	10
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

- The portion of total EDP expenditures for the top 20 companies will range between 60% and 68% in 1985.
- Applying the distribution of EDP expenditures by company size to total EDP expenditures by application (Exhibit 5) results in the distribution of total EDP expenditures by company size and application, as shown in Exhibit 7 and summarized in Exhibit 8.
 - The top 20 oil companies accounted for 70% of total EDP expenditures in 1980.
 - Indeed, the smaller oil companies are forecast to increase EDP expenditures at a faster rate, between 49% and 51% annually, compared to 44% for the top 20.
- Using survey data and expert opinion, the portion of EDP expenditures for in-house versus computer services for each company size and for each exploration application was determined for 1980 and forecast for 1985, as shown in Exhibit 9.
 - Experiencing expert personnel shortage and loss, the top 20 oil companies are shifting exploration processing to computer services vendors.
 - With increased EDP expenditures and the wider availability of cost-effective exploration processing on mega minicomputers, some shift to in-house processing is expected for the independents.
- Applying the portion of EDP expenditures used for computer services by company size and application (Exhibit 9) to total EDP expenditures by company size and application results in the forecast of computer services expenditures by company size, as shown in Exhibit 10.

EXHIBIT 7

DISTRIBUTION OF TOTAL EDP EXPENDITURES FOR
PETROLEUM EXPLORATION BY COMPANY SIZE IN 1980-1985

APPLICATION	(\$ MILLIONS)									
	MAJOR		SEMI-MAJOR		LARGE INDEPENDENT		SMALL INDEPENDENT		TOTAL	
	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985
INITIAL SEISMIC PROCESSING	\$100	\$ 530	\$ 45	\$ 250	\$ 45	\$ 290	\$ 30	\$ 190	\$ 220	\$1,260
INITIAL SEISMIC INTERPRETATION	185	1,075	90	510	80	590	55	385	410	2,560
SEISMIC REPROCESSING, ANALYSIS, AND MODELING	170	1,080	85	530	70	550	15	240	340	2,400
WELL LOG ANALYSIS	20	70	10	35	8	40	7	25	45	170
MAPPING	70	615	20	205	17	160	8	50	115	1,030
TOTAL	\$545	\$3,370	\$250	\$1,530	\$220	\$1,630	\$115	\$890	\$1,130	\$7,420

EXHIBIT 8

FORECAST OF EDP EXPENDITURES FOR PETROLEUM EXPLORATION BY COMPANY SIZE, 1980-1985

COMPANY SIZE	1980 (\$ MILLIONS)	PORTION (PERCENT)	1985 (\$ MILLIONS)	AAGR 1985/1980 (PERCENT)
MAJOR	\$ 545	48%	\$3,370	44%
SEMI-MAJOR	250	22	1,530	44
LARGE INDEPENDENT	220	20	1,630	49
SMALL INDEPENDENT	115	10	890	51
TOTAL	\$1,130	100%	\$7,420	46%

EXHIBIT 9

PORTION OF EDP EXPENDITURES FOR PETROLEUM EXPLORATION UTILIZED FOR COMPUTER SERVICES BY APPLICATION IN 1980-1985

APPLICATION	COMPUTER SERVICES PORTION (PERCENT)							
	MAJOR		SEMI-MAJOR		LARGE INDEPENDENT		SMALL INDEPENDENT	
	1980	1985	1980	1985	1980	1985	1980	1985
INITIAL SEISMIC PROCESSING	40%	45%	65%	70%	80%	75%	92%	90%
INITIAL SEISMIC INTERPRETATION	40	45	65	70	80	75	92	90
SEISMIC REPROCESSING, ANALYSIS, AND MODELING	20	25	50	55	70	60	85	80
WELL LOG ANALYSIS	15	15	20	20	40	35	60	55
MAPPING	10	20	10	20	50	50	80	80

DISTRIBUTION OF COMPUTER SERVICES EXPENDITURES FOR
PETROLEUM EXPLORATION BY COMPANY SIZE IN 1980-1985

APPLICATION	(\$ MILLIONS)									
	MAJOR		SEMI-MAJOR		LARGE INDEPENDENT		SMALL INDEPENDENT		TOTAL	
	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985
INITIAL SEISMIC PROCESSING	\$ 40	\$ 240	\$ 30	\$ 176	\$ 36	\$ 215	\$ 28	\$ 170	\$ 134	\$ 801
INITIAL SEISMIC INTERPRETATION	74	485	59	357	64	440	51	345	248	1,627
SEISMIC REPROCESSING, ANALYSIS, AND MODELING	34	270	42	290	49	330	13	190	138	1,080
WELL LOG ANALYSIS	3	10	2	7	3	15	4	15	12	47
MAPPING	7	120	2	40	8	80	6	40	23	280
TOTAL	\$158	\$1,125	\$135	\$870	\$160	\$1,080	\$102	\$760	\$555	\$3,835

- Computer services expenditures of over \$550 million in 1980, 49% of total EDP expenditures, will rise to over \$3.8 billion in 1985 or 52% of total EDP expenditures, a 47% AAGR over five years.
 - EDP expenditures by majors for computer services, 28% of the total in 1980, will rise to 29% by 1985.
 - Computer services expenditures for the semi majors, 22% of the total in 1980, will rise to 23% by 1985.
 - Increased computer services expenditures by the top 20 companies will more than offset decreases by the independents causing expenditures for computer services to grow at a faster rate than those for in-house operations.
- Using survey data and expert opinion, estimates were made of the market for software products and professional services by application for 1980 and forecast for 1985, as shown in Exhibit 11.
 - Both software products and professional services will experience their greatest growth in the reprocessing, analysis and modeling and mapping application areas.
- Using survey data and expert opinion, the portion of each type of processing service for each application was determined for 1980 and forecast for 1985, as shown in Exhibit 12.
 - Faced with expert personnel shortage and loss, the top 20 oil companies are contracting with computer services vendors for dedicated processing centers.

EXHIBIT 11

DISTRIBUTION OF SOFTWARE PRODUCTS AND PROFESSIONAL SERVICES FOR PETROLEUM EXPLORATION BY APPLICATION, 1980-1985

APPLICATION	(\$ MILLIONS)			
	SOFTWARE PRODUCTS		PROFESSIONAL SERVICES	
	1980	1985	1980	1985
INITIAL SEISMIC PROCESSING	\$ 6	\$ 20	\$ 8	\$ 20
INITIAL SEISMIC INTERPRETATION	6	25	8	30
SEISMIC REPROCESS- ING, ANALYSIS, AND MODELING	7	35	16	55
WELL LOG ANALYSIS	1	5	1	5
MAPPING	5	25	2	25
TOTAL	\$25	\$110	\$35	\$135

DISTRIBUTION OF PROCESSING SERVICES EXPENDITURES FOR
PETROLEUM EXPLORATION BY TYPE OF DELIVERY, 1980-1985

APPLICATION	PORTION (PERCENT)									
	INTER- ACTIVE		REMOTE BATCH		DATA BASE SERVICES		BATCH		FACILITIES MANAGE- MENT	
	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985
INITIAL SEISMIC PROCESSING	2%	5%	5%	10%	3%	5%	65%	40%	25%	40%
INITIAL SEISMIC INTERPRETATION	5	10	5	10	3	5	62	35	25	40
SEISMIC REPROCESS- ING, ANALYSIS, AND MODELING	10	20	20	25	3	8	52	22	15	25
WELL LOG ANALYSIS	10	25	25	30	20	25	30	10	15	10
MAPPING	15	30	35	30	8	10	30	10	12	20

- The availability of mega-minis with large central memories, array processors, and effective multitasking operating systems enables seismic processing vendors to offer FM arrangements at attractive rates.
- Interactive and remote batch processing will replace some batch processing in all five application areas.
- Applying the distribution of processing services expenditures shown in Exhibit 12 to the computer services expenditures by application (Exhibit 10) less the distribution to software products and professional services (Exhibit 11) results in the distribution of processing services expenditures by type of delivery, as shown in Exhibit 13; this is summarized in the forecast of computer services expenditures for petroleum exploration, as shown in Exhibit 14.
 - Facilities management is a viable marketplace, growing from 20% of total computer services expenditures in 1980 to 32% in 1985, for a 62% AAGR over the forecast period.
 - Improvement in communication technology and initial processing, and increased sophistication in software for reprocessing will accelerate the growth of remote batch services.
 - Remote front-end intelligence to mainframes and multitasking capability of mega minis coupled with graphics software and CAD systems will accelerate the use of interactive processing in all application areas, but particularly in seismic reprocessing, modeling, and mapping.
 - Data base services, including seismic, geographic, tract and well history, and satellite, starting from a low base (\$50 million) will become a significant mode of delivery by seismic services vendors.

DISTRIBUTION OF PROCESSING SERVICES EXPENDITURES FOR
PETROLEUM EXPLORATION BY TYPE OF DELIVERY , 1980-1985

APPLICATION	(\$ MILLIONS)									
	INTER- ACTIVE		REMOTE BATCH		DATA BASE SERVICES		BATCH		FACILITIES MANAGE- MENT	
	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985
INITIAL SEISMIC PROCESSING	\$ 2	\$ 38	\$ 6	\$ 75	\$ 4	\$ 38	\$ 78	\$ 305	\$ 30	\$ 305
INITIAL SEISMIC INTERPRETATION	12	157	12	157	6	78	145	550	59	630
REPROCESSING ANALYSIS AND MODELING	12	200	22	240	4	80	60	220	17	250
WELL LOG ANALYSIS	1	9	3	11	2	9	3	4	1	4
MAPPING	2	70	6	70	1	22	5	22	2	46
TOTAL	\$30	\$475	\$50	\$550	\$15	\$230	\$290	\$1,100	\$110	\$1,235

EXHIBIT 14

FORECAST OF COMPUTER SERVICES EXPENDITURES FOR PETROLEUM EXPLORATION BY MODE OF DELIVERY, 1980-1985

COMPUTER SERVICE	(\$ MILLIONS)		AAGR 1985/1980 (PERCENT)
	1980	1985	
PROCESSING SERVICES			
REMOTE COMPUTING			
- INTERACTIVE	\$ 30	\$ 475	74%
- REMOTE BATCH	50	550	62
- DATA BASE SERVICES	15	230	73
BATCH	290	1,100	31
FACILITIES MANAGEMENT	110	1,235	62
TOTAL PROCESSING SERVICES	\$495	\$3,590	49%
SOFTWARE PRODUCTS	25	110	35
PROFESSIONAL SERVICES	35	135	31
TOTAL COMPUTER SERVICES	\$555	\$3,835	47%

2. PRODUCTION

- The respondents interviewed were primarily located in petroleum production research organizations or were specialists in reservoir simulation. The forecast that follows relates only to EDP expenditures for petroleum reservoir simulation.
- Data gathered from the survey and expert opinion indicated that for black oil reservoir and enhanced recovery simulation:
 - The major oil companies currently account for over 70% of all activity.
 - The majors contract out about 30% of the effort.
 - The top 20 companies probably account for over 90% of all activity.
 - The current computer services market worldwide is about \$75 million.
 - About 80% of all services are for U.S. companies versus foreign governments and national oil companies.
 - Use of reservoir simulation modeling will expand to the independents because of government decontrol of oil.
 - The market is growing at about 30% per year, limited by the shortage of qualified personnel and by the price of supercomputers.
- Using survey data and expert opinion, the portion of total EDP expenditures for reservoir simulation utilized for each company size was estimated for 1980 and forecast for 1985, as shown in Exhibit 15.
 - The top 20 companies, majors and semi-majors, account for over 90% of total EDP expenditures.

EXHIBIT 15

DISTRIBUTION OF EDP EXPENDITURES FOR PETROLEUM RESERVOIR SIMULATION BY COMPANY SIZE, 1980-1985

COMPANY SIZE	PORTION (PERCENT)	
	1980	1985
MAJOR	70%	63%
SEMI-MAJOR	23	22
LARGE INDEPENDENT	5	11
SMALL INDEPENDENT	2	4
TOTAL	100%	100%

- The independents' portion will double to 15% by 1985.
- Using 80% of a \$75 million computer services base, coupled with survey data and expert opinion concerning the portion of EDP expenditures the majors and semi-majors spend on computer services, resulted in an assessment of total 1980 U.S. EDP expenditures for reservoir simulation at \$120 million.
- The forecast that is developed views EDP expenditures for petroleum reservoir simulation:
 - On an annualized basis; that is, equipment costs are imputed on an equivalent lease basis.
 - As if all reservoir simulation was accomplished by computer services vendors.
- To the extent that the forecast divides total reservoir simulation data processing between in-house and computer services, the forecast may overstate what petroleum companies report they spend on reservoir simulation in-house.
- Applying the distribution of EDP expenditures by company size, as shown in Exhibit 15, to the 1980 total, and utilizing a 31% average annual growth rate over the five-year forecast period results in a forecast of EDP expenditures for petroleum reservoir simulation, as shown in Exhibit 16.
 - Although the major portion of total expenditures, over 80%, will still be made by the top 20 oil companies in 1985, expenditure growth for the independents will be nearly double that of the majors.
- Using survey data and expert opinion, the portion of EDP expenditures that each size company spends in-house versus computer services was determined for 1980 and forecast for 1985, as shown in Exhibit 17.

EXHIBIT 16

FORECAST OF EDP EXPENDITURES FOR PETROLEUM RESERVOIR SIMULATION BY COMPANY SIZE, 1980-1985

COMPANY SIZE	(\$ MILLIONS)		AAGR 1985/1980 (PERCENT)
	1980	1985	
MAJOR	\$ 84	\$290	28%
SEMI-MAJOR	28	100	29
LARGE INDEPENDENT	6	50	53
SMALL INDEPENDENT	2	20	58
TOTAL	\$120	\$460	31%

EXHIBIT 17

DISTRIBUTION OF EDP EXPENDITURES FOR PETROLEUM RESERVOIR SIMULATION BETWEEN IN-HOUSE AND COMPUTER SERVICES, 1980-1985

COMPANY SIZE	PORTION (PERCENT)			
	1980		1985	
	IN-HOUSE	COMPUTER SERVICES	IN-HOUSE	COMPUTER SERVICES
MAJOR	70%	30%	75%	25%
SEMI-MAJOR	10	90	15	85
LARGE INDEPEN- DENT	-	100	5	95
SMALL INDEPEN- DENT	-	100	1	99

- To the extent that independents use reservoir simulation they use either consultants or computer services vendors.
- Over time, the majors can be expected to shift more reservoir simulation in-house to support the purchase of large scientific mainframes.
- Applying the portion of EDP expenditures for computer services (Exhibit 17) to total EDP expenditures by company size (Exhibit 16) results in the forecast of EDP expenditures for computer services shown in Exhibit 18.
 - The 1980 market, \$60 million, will grow at a 30% AAGR over the forecast period exceeding \$200 million by 1985.
 - Computer services growth rates for the independents will be over twice those for the majors.
 - By 1985 approximately 30% of the market will be offering computer services to the independents.
- The portion of total EDP expenditures for reservoir simulation used in-house, 50% in 1980, will gradually increase to 52% by 1985, the net resulting from the shift of the majors in-house exceeding the increased use of reservoir simulation by the independents, primarily through computer services.
- Using survey data and expert opinion, the portion of EDP expenditures for processing services, software products, and professional services was determined for 1980 and forecast for 1985, as shown in Exhibit 19.
 - Reservoir simulation processing is delivered primarily in remote batch mode.
 - Use of interactive processing is increasing, particularly the graphic review of results prior to final output.

EXHIBIT 18

FORECAST OF EDP EXPENDITURES FOR COMPUTER SERVICES FOR PETROLEUM EXPLORATION BY COMPANY SIZE, 1980-1985

COMPANY SIZE	(\$ MILLIONS)		AAGR (PERCENT) 1985/1980
	1980	1985	
MAJOR	\$26	\$ 70	22%
SEMI-MAJOR	26	85	27
LARGE INDEPENDENT	6	45	49
SMALL INDEPENDENT	2	20	58
TOTAL	\$60	\$220	30%

EXHIBIT 19

FORECAST OF EDP EXPENDITURES FOR COMPUTER SERVICES FOR PETROLEUM RESERVOIR SIMULATION BY MARKET DELIVERY, 1980-1985

COMPUTER SERVICE	(\$ MILLIONS)		AAGR 1985/1980 (PERCENT)
	1980	1985	
PROCESSING SERVICES			
REMOTE COMPUTING			
- INTERACTIVE	\$ 7	\$ 40	42%
- REMOTE BATCH	28	105	30
- DATA BASE SERVICES	-	-	-
BATCH	-	-	-
FACILITIES MANAGEMENT	-	-	-
TOTAL PROCESSING SERVICES	\$35	\$145	33%
SOFTWARE PRODUCTS	10	28	23
PROFESSIONAL SERVICES	15	47	26
TOTAL COMPUTER SERVICES	\$60	\$220	30%

- There is no discernible market for batch or FM.
- There is and will remain a significant software products and professional services component, 42% in 1980, still exceeding one-third of total expenditures by 1985.

DISTRIBUTION OF RESPONDENT EXPLORATION
DATA PROCESSING BUDGETS
BY COMPANY SIZE IN 1980

COMPANY SIZE	SAMPLE SIZE	PORTION OF EDP BUDGET (PERCENT)			TOTAL (PERCENT)
		SEISMIC DATA REDUCTION REPROCES- SING AND ANALYSIS	MAPPING	WELL LOG ANALYSIS AND OTHER	
MAJOR	2	-	-	-	-
SEMI-MAJOR	4	84%	11%	5%	100%
LARGE IN- DEPENDENT	4	86	11	3	100
SMALL IN- DEPENDENT	5	88	8	4	100
AVERAGE	15	86%	10%	4%	100%

- INSUFFICIENT DATA

PETROLEUM COMPANY METHODS AND PLANS FOR
HANDLING PROCESSING OF SEISMIC DATA
AS REPORTED BY RESPONDENTS

COMPANY SIZE	SAMPLE SIZE	PORTION (PERCENT)				
		PRIMARY METHOD OF ACCOMPISHING SEISMIC PROCESSING		PORTION PLANNING TO CHANGE	PORTION INTERESTED IN RCS OFFERING	
		SERVICE COMPANY	IN-HOUSE			
MAJOR	3	-	100%	-	100%	-
SEMI-MAJOR	4	50%	50	-	100	50%
LARGE INDEPENDENT	10	80	20	-	10	10
SMALL INDEPENDENT	25	88	-	12%	15	11
TOTAL	42	-	-	-	-	-

EXPENDITURES FOR GEOPHYSICAL DATA PROCESSING AS REPORTED BY RESPONDENTS

COMPANY SIZE	SAMPLE SIZE	AVERAGE 1980 ANNUAL REVENUES (\$ MILLION)	AVERAGE 1980 EXPLOR- ATION BUDGET (\$ MILLION)	AVERAGE 1980 SEISMIC BUDGET (\$ MILLION)	PORTION (PERCENT)	AVERAGE 1981 SEISMIC BUDGET (\$ MILLION)	AVERAGE 1981/1980 GROWTH (PERCENT)	AVERAGE 1983/1980 GROWTH RATES (PERCENT)
MAJOR	3	\$39,200	-	\$50.0	-	\$68.0	35%	35%
SEMI-MAJOR	4	11,800	-	20.0	-	28.0	40	35
LARGE IN- DEPENDENT	10	1,600	\$17.4	1.8	10%	3.0	66	53
SMALL IN- DEPENDENT	27	48	8.8	0.5	8	0.8	55	42

- INSUFFICIENT DATA

APPENDIX A: INTERVIEW PROGRAM

INPUT

INTERVIEW SAMPLE

COMPANY SIZE/TYPE	NUMBER OF INTERVIEWS				TOTAL
	EXPLORATION		PRODUCTION		
	ON-SITE	PHONE	ON-SITE	PHONE	
MAJOR	2	3	1	4	10
SEMI-MAJOR	3	3	2	1	9
LARGE INDEPENDENT	1	10	1	-	12
SMALL INDEPENDENT	1	26	1	-	28
PROCESSING SERVICES COMPANIES	-	6	-	-	6
CONSULTING COMPANIES	1	2	-	3	6
TOTAL	8	50	5	8	71

MAJOR PETROLEUM COMPANIES INTERVIEWED

COMPANY	INTERVIEW TYPE			
	EXPLORATION		PRODUCTION	
	ON-SITE	PHONE	ON-SITE	PHONE
AMOCO	-	1	-	1
EXXON.	-	-	-	1
MOBIL	-	-	-	1
SHELL	-	-	-	1
STANDARD OIL OF CALIF.	2	-	1	-
TEXACO	-	2	-	-
TOTAL	2	3	1	4

SEMI-MAJOR PETROLEUM COMPANIES INTERVIEWED

COMPANY	INTERVIEW TYPE			
	EXPLORATION		PRODUCTION	
	ON-SITE	PHONE	ON-SITE	PHONE
OCCIDENTAL OIL	1	-	1	1
STANDARD OIL OF OHIO	1	-	1	-
TENNECO	-	2	-	-
UNION OIL COMPANY	1	1	-	-
TOTAL	3	3	2	1

LARGE INDEPENDENT
PETROLEUM COMPANIES INTERVIEWED

COMPANY	INTERVIEW TYPE			
	EXPLORATION		PRODUCTION	
	ON-SITE	PHONE	ON-SITE	PHONE
CHAMPLIN OIL	-	2	-	-
COASTAL OIL	-	1	-	-
DIAMOND SHAMROCK	-	1	-	-
HUSKY OIL COMPANY	-	1	-	-
KANSAS-NEBRASKA GAS CO.	-	1	-	-
KERR-McGEE	-	1	-	-
KOCH EXPLORATION	-	1	-	-
McCULLOCH OIL	1	-	1	-
MITCHELL ENERGY	-	1	-	-
QUAKER STATE	-	1	-	-
TOTAL	1	10	1	-

SMALL INDEPENDENT
PETROLEUM COMPANIES INTERVIEWED

COMPANY	INTERVIEW TYPE			
	EXPLORATION		PRODUCTION	
	ON-SITE	PHONE	ON-SITE	PHONE
ANSHUTZ CORP.	-	1	-	-
TEXAS INTERNATIONAL PETROLEUM	-	1	-	-
FOREST OIL	-	2	-	-
SEAWARD RESOURCES	-	1	-	-
COLUMBIA GAS DEVELOPMENT CORP.	-	1	-	-
PIONEER PRODUCTION	-	1	-	-
McFARLAND ENERGY INC.	-	1	-	-
BIRD OIL CO.	-	1	-	-
HERSHEY OIL	-	1	-	-
OGLE PETROLEUM	1	-	1	-
ARGO PETROLEUM	-	1	-	-
BUTTES RESOURCES	-	1	-	-
HILLARD GAS AND OIL	-	1	-	-
TEXFEL	-	1	-	-
CABEEN EXPLORATION	-	1	-	-
MISSION RESOURCES	-	1	-	-
CRESTMONT OIL AND GAS	-	1	-	-
CARLSBERG PETROLEUM	-	1	-	-
GREAT BASIN PETROLEUM	-	1	-	-

(Continued)

SMALL INDEPENDENT
PETROLEUM COMPANIES INTERVIEWED (CONT.)

COMPANY	INTERVIEW TYPE			
	EXPLORATION		PRODUCTION	
	ON-SITE	PHONE	ON-SITE	PHONE
ABO PETROLEUM	-	1	-	-
AMERICAN QUASAR PETROLEUM	-	1	-	-
BASIC EARTH SCIENCES CORP.	-	1	-	-
BAYOU LANDS EXPLORATION	-	1	-	-
CAMPBELL ENERGY CORP.	-	1	-	-
HAMILTON BROTHERS OIL	-	1	-	-
LADD PETROLEUM	-	1	-	-
TOTAL	1	26	1	-

PETROLEUM PROCESSING SERVICES
COMPANIES INTERVIEWED

COMPANY	INTERVIEW TYPE			
	EXPLORATION		PRODUCTION	
	ON-SITE	PHONE	ON-SITE	PHONE
DENVER PROCESSING CENTER	-	1	-	-
DIGICON INC.	-	1	-	-
GEOSOURCE INC.	-	1	-	-
GEOTRACE	-	1	-	-
GOLDEN GEOPHYSICAL	-	1	-	-
WESTERN GEOPHYSICAL	-	1	-	-
TOTAL	-	6	-	-

PETROLEUM CONSULTING SERVICES
COMPANIES INTERVIEWED

COMPANY	INTERVIEW TYPE			
	EXPLORATION		PRODUCTION	
	ON-SITE	PHONE	ON-SITE	PHONE
INTERCOMP RESOURCES DEVELOPMENT	-	-	-	1
McCLELLAND ENGINEERS	1	-	-	-
NOLAN ASSOCIATES	-	-	-	1
SCIENTIFIC SOFTWARE CORPORATION	-	-	-	1
TEKNICA RESOURCES	-	1	-	-
ZENITH EXPLORATION (NEIDELL)	-	1	-	-
TOTAL	1	2	-	3

APPENDIX B: QUESTIONNAIRE

INPUT

I. INTRODUCTION

Do you have responsibility for:

☐ Exploration ☐ Production ☐ Both

If not both, who has responsibility for:

☐ Production

Name Phone No.

Or

☐ Exploration

Name Phone No.

If responsible for exploration or both, start at Section II below,
otherwise, go to Section III.

II. EXPLORATION

1. What are the major data processing applications and how is each accomplished?

APPLICATION	HOW ACCOMPLISHED				
	SOFT- WARE VENDOR	IN-HOUSE		SERVICES VENDOR	PORTION OF TOTAL PRO- CESSING (%)
		MAIN- FRAME MODEL	TURNKEY/ MINI- MODEL		
<input type="checkbox"/> Seismic Pre Processing					
<input type="checkbox"/> Seismic Data Reduction (conventional pro- cessing)					
<input type="checkbox"/> Seismic Analysis					
- wavelet analysis					
- velocity/dig analysis					
- stratigraphic analysis					
- modeling					
<input type="checkbox"/> Mapping					
<input type="checkbox"/> Well log analysis					
<input type="checkbox"/> Data Bases					
<input type="checkbox"/> Other: _____					

Comments: _____

2. How much do you spend on seismic data processing?

☐ Don't know

\$ _____ ☐ Annually ☐ Monthly in 1980

\$ _____ ☐ Annually ☐ Monthly in 1981

_____ Line miles/yr.

How much per year will this increase over the next 3-4 years?

☐ Don't know

☐ <10%/year ☐ 10-20%/yr ☐ 30-40%/yr ☐ >40%/yr

or

☐ \$ _____ by 198__.

3. How do you currently handle your input and output to remote locations?

Input

☐ Mail Tapes ☐ Data Transmission _____ bps lines

☐ Other _____

Comments: _____

Output

☐ Mail results - plots

☐ Use remote graphics terminal

☐ distributed processing (remote mini)

☐ Other _____

Comments: _____

Are there any improvements you would like to see in the areas of input/output?

Input

Output

IF SEISMIC DATA PROCESSING DONE **IN-HOUSE** Go to Question 11

4. Do you have any plans to change your current method of doing seismic data reduction/analysis?

☐ No **Skip** question 5.

☐ Shift in-house to _____ mainframe
Vendor/Model

☐ Shift in-house to _____ minicomputer
Vendor/Model

☐ Other: _____

☐ Comments: _____

5. Could you outline the rationale for shifting to an in-house . . .

☐ Mainframe ☐ Minicomputer?

☐ Price performance

☐ Expenditure levels

☐ Application products

☐ Upward Compatibility (DEC VAX)

☐ Interactive CRT/Graphics terminals

☐ Other

6. Would you be interested in a remote computer services offering for seismic data processing/analysis?

☐ No

☐ If not, would a service that provided computerized training tools and "user friendly systems" to guide seismic analysis and interpretation alter your decision?

☐ No

☐ Comments: _____

If yes,

☐ Services offering for

☐ Seismic data processing ☐ Seismic data analysis

☐ both

☐ Preferred method for handling Input

☐ Mail Tapes

☐ Remote data transmission _____ bps lines

☐ Other _____

☐ Comments: _____

☐ Preferred data reduction characteristics

☐ Conventional common depth point modules (Sorting, normal move out, static corrections)

☐ Filtering Capabilities (time domain, frequency, deconvolutions)

☐ F.K. filtering (frequency, wave filtering)

☐ Static and dynamic corrections

☐ Comments: _____

☐ Preferred Analysis System characteristics

- ☐ Wavelett Analysis
- ☐ Time-series Analysis
- ☐ Frequency Wavelett Analysis
- ☐ Stratigraphic Analysis
- ☐ Structural Analysis
- ☐ 3-D Processing Algorithms
- ☐ Fourier Transforms
- ☐ Migration Analysis
- ☐ Seismic Modeling
- ☐ Other _____

☐ Comments: _____
_____☐ Preferred processing system characteristics☐ Micro based graphics terminal

- ☐ Pen plotter ☐ Yes ☐ No
- ☐ Electrostatic plotter ☐ Yes ☐ No
- ☐ Color CRT ☐ Yes ☐ No
- ☐ Price range \$ _____ to _____ /month
\$ _____ to _____ purchase

☐ Remote mini with graphics work stations

- ☐ Pen plotter ☐ Yes ☐ No
- ☐ Electrostatic plotter ☐ Yes ☐ No
- ☐ Color CRT ☐ Yes ☐ No
- ☐ Price range \$ _____ to _____ /month
\$ _____ to _____ purchase

☐ Comments: _____

7. Are there any other exploration applications that you would be interested in having offered on a remote computing basis?

☐ No

☐ Mapping:

☐ Batch ☐ Interactive ☐ Interactive with linked
data bases

Please comment on characteristics including expenditures:

☐ Well log analysis:

Please comment on characteristics including expenditures:

☐ Other

Comments:

8. What data management and data base services do you currently use?

☐ None

DATA MANAGE- MENT SYSTEM (DBMS)	DATA BASE NAMES	VENDOR	APPLICATION/ USE

☐ On a scale of 1 to 10 where 10 is high, please rate the growing importance of data management and data base services to your organization?

Data Management _____

Data Base Services _____

☐ Comments: (include expenditures estimates if known)

9. Are there other data base services you would like to see offered on a remote computing services basis?

- ☐ No
- ☐ Mapping
- ☐ Land Sattelite
- ☐ Well history
- ☐ Magnetic and gravitational fields
- ☐ Seismic lines/lease boundries
- ☐ Data storage and correlation
- ☐ Other _____
- ☐ Please comment on characteristics of data base services, including expenditures:

10. Under what conditions is data security viewed as a concern when using a computer service?

- ☐ No
- ☐ Comments: _____

GO TO SECTION III PRODUCTION

IN-HOUSE EDP

11. What portion of your in-house computer is devoted to exploration data processing?

☐

Don't know

☐

<25%

☐

25-50%

☐

50-75%

☐

>75%

Comments: _____

12. Do you have plans to upgrade your mainframe or change the method of handling your exploration data processing?

☐

No

☐

Upgrade mainframe to _____ in 198__

Vendor/Model

☐

Shift to in-house _____ minicomputer

Vendor/Model

☐

Shift to Distributed Data Processing

☐

For seismic data reduction

☐

For seismic analysis

☐

Other _____

☐

Other _____

Comments: _____

13. Could you outline the rationale for using/shifting to an in-house minicomputer?

☐ Price performance _____

☐ Expenditure levels _____

☐ Application products _____

☐ Upward Compatability (DEC/VAX) _____

☐ Interactive CRT/Graphics Terminals _____

☐ Other _____

14. If upgrading or procuring a new mainframe, please rate the importance of and comment on the following factors: (Use a scale of 1 to 10, where 10 is highly important)

☐ Not upgrading ☐ Not procuring

Rating

☐ Homogeneous product line (Upward compatibility)

Comments (Range of price/performance)

☐ Specific Seismic Analysis/Modeling Applications

Comments (3-D processing algorithms, enhanced analysis systems)

☐ Greater than 32 bit/floating point word size
Single precision

Comments: (32 vs 64, single vs double precision)

☐ Attached Processor

Comments: (Range of price, range of performance, is market changing?)

14. (Cont.)

Rating☐ Vector Instruction Set

Comments: (Range or price, range of performance, value relative to attached processor)

(Importance of vector technology relative to seismic applications)

☐ Data Management Systems

Comments: (DBMS, Types of Data)

15. What attached processor features will be required by 1984?

- ☐ 64 bit word
- ☐ Fortran programmability
- ☐ Increased multiply/add speeds
- ☐ Upward compatibility
- ☐ Other _____

Comments: _____

16. In considering distributing exploration data processing between central site, regional sites and remote sites, please comment on the function distributed and the range of price/performance.

☐ Are not considering

☐ Remote sites

Functions: _____

Price/performance: _____

☐ Regional Sites

☐ None

☐ Functions: _____

☐ Price/performance: _____

☐ Central sites

☐ Functions: _____

☐ Price/performance: _____

17. What data management software and data bases do you currently use?

☐ None

DATA MANAGE- MENT SYSTEMS (DBMS)	DATA BASE NAMES	VENDOR	APPLICATION/ USE

- ☐ On a scale of 1 to 10, where 10 is high, please rate the growing importance of data management and data bases to your organization?

Data management _____

Data Bases _____

- ☐ Comments: (include expenditure estimates if known)

18. Are there other data bases/applications you would like to see offered? if so, how?

☐ No

	In-House	Services
<input type="checkbox"/> Mapping	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Land Satellite	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Well History	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Magnetic and gravitational fields	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> <u>Seismic lines</u> /lease boundaries	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Data storage and correlation	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Other _____	<input type="checkbox"/>	<input type="checkbox"/>

☐ Please comment on characteristics of data base services, including expenditures:

19. To what extent do/would you (if available) use outside services for seismic data reduction/analysis:

☐

None

☐

On a temporary overload basis

☐

On an interim basis until in-house system is upgraded/installed

☐

Comments: (estimate expenditure levels)

III. PRODUCTION

20. What are the major applications and how is each accomplished?

APPLICATION	HOW ACCOMPLISHED				
	SOFTWARE VENDOR	IN-HOUSE		SERVICES VENDOR	PORTION OF TOTAL PRO- CESSING (%)
		MAIN- FRAME MODEL	TURNKEY/ MINI MODEL		
<input type="checkbox"/> Reservoir Simulation					
<input type="checkbox"/> Secondary or Enhanced Recovery					
<input type="checkbox"/> Production Accounting					
<input type="checkbox"/> Drilling Assistance					
<input type="checkbox"/> Offshore Structural Analysis					
<input type="checkbox"/> Process Simulation					
<input type="checkbox"/> Other _____					

Comments: _____

21. How much do you spend on production data processing?

\$ _____ ☐ Annually ☐ Monthly in 1980

\$ _____ ☐ Annually ☐ Monthly in 1981

How much per year do you expect this will increase over the next 3-4 years?

☐ Don't know

☐ <10%/year ☐ 10-20%/year ☐ 30-40%/year

☐ >40% ☐ \$ _____ by 198 ____.

Comments (Why?)

IF PRODUCTION APPLICATIONS DONE **IN-HOUSE** GO TO QUESTION 28

SERVICES

22. Do you have any plans to change your current method of doing reservoir or enhanced recovery simulation?

☐ No

☐ Shift to _____ mainframes
Vendor/Model

☐ Shift to _____ minicomputer
Vendor/Model

☐ Other _____

☐ Comments: _____

23. Could you outline the rationale for shifting to an inhouse . . .

☐ Mainframe ☐ Minicomputer

☐ Price Performance _____

☐ Expenditure level _____

☐ Application products _____

☐ Upward Compatibility
(DEC VAX) _____

☐ Interactive CRT /Graphics
Terminals _____

☐ Other _____

24. Would you be interested in a remote computing service offering for reservoir simulation modeling?

☐

No

☐

Preferred modeling characteristics

☐

3-D

☐

Multi-phase (oil, water, gas)

☐

Size of Model no. of Grid Blocks _____

☐

Other _____

Comments: _____

☐

Preferred processing system characteristics

☐

Interactive or ☐ remote batch

☐

Micro based graphic terminals

☐

Color CRT

☐

Yes

☐

No

☐

Price Range \$ _____ to \$ _____/month

\$ _____ to \$ _____/purchase

☐

Remote mini with graphics work stations

☐

Color CRT

☐

Yes

☐

No

☐

Price Range \$ _____ to \$ _____/month

\$ _____ to \$ _____/purchase

☐

Comments: _____

25. Would you be interested in a remote computing service offering for Enhanced Recovery Modeling?

☐ No

☐ Preferred Modeling Characteristics

☐ 3-D

☐ Injection Type (Steam _____, CO₂ _____, Water _____, Other _____)
Rate order of importance (1 to 4)

Comments: _____

☐ Preferred processing system characteristics

☐ Interactive or ☐ Remote Batch

☐ Micro based graphic terminal

☐ Color CRT ☐ Yes ☐ No

☐ Price Range \$ _____ to _____/month

Remote mini with graphics work station

☐ Color CRT ☐ Yes ☐ No

☐ Price Range \$ _____ to _____/month

\$ _____ to _____/purchase

☐ Comments: _____

26. What Data Management and Data Base Services do you currently use?

☐ None

DATA MANAGE- MENT SYSTEM (DBMS)	DATA BASE NAMES	VENDOR	APPLICATION/ USE

☐ On a Scale of 1 to 10, where 10 is high, please rate the growing importance of data management and data base services to your production activity.

Data Management _____

Data Base Services _____

☐ Comments: (Include expenditure level if known)

27. Are there other data base services you would like to see offered on a remote computing services basis?

☐

No

☐

Data Storage and correlation

☐

Data Bases

TYPE OF DATA	APPLICATION/USE	EXPENDITURE LEVEL/YEAR

☐

Please comment on characteristics of data base services, including annual expenditures:

THANK YOU

END

IN HOUSE EDP

28. What portion of your in-house computer is devoted to production data processing?

☐

Don't know

☐

<25%

☐

25-50%

☐

50-75%

☐

>75%

29. Do you have plans to upgrade your mainframe or change the method of handling your production data processing?

☐

No

☐

Upgrade mainframe to _____ in 198__.

Vendor/Model

☐

Other _____

☐

Comments: _____

30. In upgrading mainframes, please rate the importance of, and comment on the following factors:

	<u>Rating</u>
<input type="checkbox"/> Homogenous product line (upward compatibility)	_____
Comments: _____	

<input type="checkbox"/> Specific Reservoir/Enhancement modeling Application	_____
Comments: (range of price/performance, plans to buy mainframe to do this application)	

<input type="checkbox"/> Greater than 32 bit single precision floating point word size	_____
Comments: (32 vs 64, single vs double precision)	

<input type="checkbox"/> Attached Processor	_____
Comments: (range of price/performance, is market changing?)	

<input type="checkbox"/> Vector Instruction Set	_____
Comments: (range of price/performance, value relative to attached processors)	

<input type="checkbox"/> Data Management Systems	_____
Comments (DBMS, type of data)	

31. What Data Management Software and Data Bases do you currently use?

☐ None

DATA MANAGE- MENT SYSTEMS (DBMS)	DATA BASE NAMES	VENDOR	APPLICATION/ USE

☐ On a scale of 1 to 10 where 10 is high, please rate the growing importance of data management and data bases to your organization?

Data Management _____

Data Bases _____

☐ Comments: (include expenditures estimate if known)

32. Are there other data bases/applications you would like to see offered? If so, how?

☐ No

	<u>In-house</u>	<u>Services</u>
<input type="checkbox"/> <u>Drilling Assistance</u>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> <u>Production Accounting</u>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> <u>Offshore Structural Analysis</u>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> <u>Process Simulation</u>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> <u>Other:</u> _____	<input type="checkbox"/>	<input type="checkbox"/>

☐ Please comment on characteristics of data base services including expenditure level.

33. To what extent do/would you (if available) use outside services
(circle)
for Reservoir Simulation Modeling.

- ☐ None
- ☐ On a temporary overload basis
- ☐ On an interim basis until in-house system is
upgraded/installed
- ☐ Comments: (estimate expenditure levels)
-
-

34. To what extent do/would you (if available) use outside services
(circle)
for Enhanced Recovery Modeling.

- ☐ None
- ☐ On a temporary overload basis
- ☐ On an interim basis until in-house system is upgraded/
installed.
- ☐ Comments: (estimate expenditure levels)
-
-

THANK YOU

END

1. How do you handle your seismic processing?

_____ In-house

_____ RCS

_____ Contracted through Service Co.

_____ Other

2. How much did you spend on seismic processing in 1980?

3. How much do you plan to spend in 1981 on seismic processing?

4. How much do you expect seismic processing costs to increase per year? _____ % Per year.

5. Do you expect to change the way you handle seismic processing within the next five years? _____ How change?

6. If services are non-contracted, and you expect to change; what applications would be the first to be brought in-house or to be done by RCS Co.?

7. Would you be interested in on RCS offering to assist you in Seismic Processing? Why/Why not?

8. How large is your firm, please indicate revenues for 1980?

9. How much is budgeted for exploration? _____

10. How much is seismic budget? _____

THANK YOU

